Copy 6
RM E51G25

NACA RM E51G25

Inactive

NACA

RESEARCH MEMORANDUM

COMBUSTION-CHAMBER PERFORMANCE CHARACTERISTICS OF A PYTHON TURBINE-PROPELLER ENGINE INVESTIGATED IN ALTITUDE WIND TUNNEL

By Carl E. Campbell

Lewis Flight Propulsion Laboratory
Cleveland, Ohio

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WASHINGTON
November 16, 1951

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

COMBUSTION-CHAMBER PERFORMANCE CHARACTERISTICS OF A PYTHON TURBINE-PROPELLER ENGINE INVESTIGATED IN ALTITUDE WIND TUNNEL

By Carl E. Campbell

SUMMARY

Combustion-chamber performance of a Python turbine-propeller engine with four tail-pipe configurations was determined in the NACA Lewis altitude wind tunnel over a range of simulated altitudes from 10,000 to 40,000 feet and engine speeds from 6800 to 8000 rpm. Fuel flow was varied at each engine speed to give full coverage of the operable engine range.

Over the range of test conditions investigated, the combustion efficiency varied from approximately 0.95 to 0.99. Combustion efficiency decreased slightly with increased altitude and increased fuel-air ratio but was not affected noticeably by changes in engine speed and exhaust-nozzle-outlet area. The combustion-chamber total-pressure-loss ratio varied from approximately 0.037 in the medium and high range of corrected shaft horsepowers to about 0.043 at low corrected shaft horsepower. The value of combustion-chamber total-pressure-loss ratio increased slightly with increased altitude at low corrected shaft horsepower, but was not affected noticeably by changes in engine speed and exhaust-nozzle-outlet area. The combustion-chamber total-pressure loss divided by the inlet impact pressure increased uniformly with increasing combustion-chamber temperature ratio from a minimum value of 1.7 to a maximum of 2.4. At a given value of combustion-chamber temperature ratio, changes in altitude, engine speed, and exhaust-nozzle-outlet area had little if any effect on the combustion-chamber total-pressure loss divided by the inlet impact pressure.

INTRODUCTION

An investigation to evaluate the performance characteristics of a Python turbine-propeller engine was conducted in the NACA Lewis laboratory altitude wind tunnel. As part of this investigation, data were obtained to evaluate the performance of the vaporizing type combustion chamber operating as an integral part of the engine. Data were obtained for four tail-pipe configurations at altitudes from 10,000 to 40,000 feet at a cowl-inlet ram pressure ratio of about 1.025. The engine was operated at speeds from 6800 to 8000 rpm and the fuel flow was changed to give various powers at each engine speed. 2253

Combustion efficiency and pressure-loss characteristics are presented as functions of corrected shaft horsepower to show the effects of engine speed, altitude, and tail-pipe configuration on performance. Combustion efficiency is also shown as a function of fuel-air ratio, and the pressure-loss characteristics are shown as a function of the temperature ratio across the combustion chamber. All combustion-chamber performance data are also presented in tabular form.

INSTALLATION AND INSTRUMENTATION

Engine

The engine was mounted in a wing segment which extended across the 20-foot diameter test section of the altitude wind tunnel (fig. 1). The production engine has a nominal static sea-level rating of 3670 shaft horsepower and 1150 pounds of jet thrust at an engine speed of 8000 rpm and a tail-pipe gas temperature of 590° C (1554° R).

A cross section of the engine is presented in figure 2. On the forward end of the compressor is mounted a two-stage planetary reduction gear through which the engine drives two four-blade, contrarotating propellers. The main components of the engine include a 14-stage axial-flow compressor, 11 combustion chambers of the vaporizing type, a two-stage turbine, and a fixed-area exhaust nozzle. In passing through the engine, the air flow is turned through an angle of 180° before entering the compressor and again after leaving the compressor so that the flow through the combustion chamber is in the downstream direction.

Combustion Chamber

The 11 direct-flow type combustion chambers are equally spaced around the outer circumference of the compressor. A cut-away drawing of one of the combustion chambers is shown in figure 3. The combustion zone of each combustion chamber (fig. 4) is separated from the outer shell by a short, domed, inner liner, which includes a mixing chamber or fuel vaporizer. A portion of the air from the annular space between the liner and the outer casing, together with fuel from a main fuel nozzle, enters the primary combustion zone through the mixing chamber, which has an exit facing upstream; hot gases passing over the mixing chamber vaporize the fuel. An auxiliary air tube is included within the fuel vaporizer to retard carbon formation on the inner surface of the vaporizer.

Additional air enters the primary combustion zone through the dome of the liner. Secondary air is added downstream of the vaporizer through liner perforations and at the end of the short inner liner. The combustion chamber length, from primary combustion zone to entry annulus of the turbine, is much greater than that of conventional combustion chambers.

To start the engine, two of the combustion chambers are equipped
2253 with combination spark plugs and starting fuel nozzles which enter the combustion zone through a hole in the center of the liner dome. The other combustion chambers are equipped with starting fuel nozzles which penetrate the side of the liner dome (fig. 4(b)), and ignition is propagated through cross-fire tubes. A valve in the fuel line to the starting fuel nozzles permits flow only while ignition is on. The fuel used throughout the investigation conformed to specification MIL-F-5616 (kerosene).

Instrumentation

Stations at which instrumentation was installed within the engine for measuring pressures and temperatures are shown in figure 2. Schematic sketches of the instrumentation at the cowl inlet (station 1), combustion-chamber inlet (station 2), turbine inlet (station 3), and exhaust-nozzle inlet (station 5) are shown in figure 5. Pressures at stations 2 and 3 were measured with mercury manometers and pressures at stations 1 and 5 were measured with water manometers; all pressures were photographically recorded. Temperatures at stations 1 and 2 were measured with iron-constantan thermocouples and the temperature at station 5 was measured with chromel-alumel thermocouples; all temperatures were automatically recorded by self-balancing potentiometers.

Fuel flow was measured by a calibrated rotameter and engine speed was measured by a stroboscopic tachometer. Engine torque was measured by means of a built-in hydraulic torquemeter which was calibrated by the manufacturer to give propeller-shaft torque in terms of hydraulic pressure. The reduction gearing power loss, which included bearing losses, was obtained from a calibration curve of gear horsepower plotted against shaft horsepower.

PROCEDURE

Investigations were conducted using three tail-pipe configurations other than the standard configuration which consisted of a 23-inch constant-diameter tail pipe 66 inches long with no exhaust nozzle. The other three configurations had a 24-inch diameter, 66-inch long tail pipe with no exhaust nozzle, a 22-inch, and a 20-inch diameter exhaust nozzle, respectively.

For the standard tail-pipe configuration, data were obtained at altitudes of 10,000, 20,000 and 30,000 feet at engine speeds from 6800 to 8000 rpm and at an altitude of 40,000 feet at engine speeds from 7400 to 8000 rpm. For the other configurations, data were obtained at altitudes of 10,000, 30,000 and 40,000 feet at engine speeds from 7600 to 8000 rpm. For all altitudes and configurations, the fuel flow was varied to obtain a range of shaft horsepower at each engine speed. Throughout the investigation, the ratio of cowl-inlet total pressure to test-section static pressure (ram pressure ratio) was maintained at about 1.025. 2253

At simulated altitudes of 10,000 and 20,000 feet, cowl-inlet air temperatures corresponding to NACA standard altitude conditions at a ram pressure ratio of 1.025 were used. At altitudes above 20,000 feet, the inlet temperature was held near -20° F, which was the minimum that could be easily maintained in the wind tunnel.

The symbols and the methods of calculation used to determine the combustion-chamber performance are given in the appendix.

RESULTS AND DISCUSSION

Combustion-chamber performance data obtained over a range of engine speeds and simulated altitudes, and for four tail-pipe configurations, are plotted to show the variation of combustion efficiency and combustion-chamber total-pressure-loss ratio with corrected shaft horsepower. Combustion efficiency is also shown as a function of fuel-air ratio, and the pressure-loss characteristics are shown as a function of the temperature ratio across the combustion chamber. The test results are presented in numerical form in table I.

The absolute values of combustion efficiency presented in this report are considered to be accurate to within approximately ±0.05, in the medium and high region of shaft horsepower. Because of inaccuracies in the torquemeter calibration at low torquemeter pressures and in the calibration of reduction gearing power loss at low power, further inaccuracy in the values of combustion efficiency is probable at low shaft horsepower.

Combustion Efficiency

The variation of combustion efficiency with corrected shaft horsepower for the engine equipped with the standard tail pipe is shown in figure 6 for altitudes from 10,000 to 40,000 feet and for a range of corrected engine speeds. Combustion efficiency decreased slightly as shaft horsepower was increased, especially at high altitude; but combustion efficiency was not appreciably changed by varying the corrected engine speed from 7006 to 8706 rpm. The variation of combustion efficiency with corrected shaft horsepower is more directly a result of variations in fuel-air ratio which produced the changes in shaft horsepower. The effect of fuel-air ratio on combustion efficiency is shown in figure 7 over the same range of operating conditions shown in figure 6. The slight decrease in combustion efficiency which occurs with increased fuel-air ratio is probably the result of the mixture becoming too rich in the combustion zone. However, this apparent trend at low power is probably the result of inaccuracies in the measurement of shaft horsepower, gear horsepower, or both, in the low shaft horsepower region.

The effect of altitude on the variation of combustion efficiency with corrected shaft horsepower and fuel-air ratio is shown in figure 8. At low shaft horsepower, the effect of altitude on combustion efficiency was negligible, but in the region of maximum shaft horsepower at a fuel-air ratio of 0.018, combustion efficiency was lowered by approximately 0.04 by increasing the altitude from 10,000 to 40,000 feet. The decrease in combustion efficiency with increased altitude at a constant value of fuel-air ratio is the result of changes in combustion-chamber-inlet pressure, temperature, and velocity.

Combustion efficiencies obtained with several turbojet engines have been shown to give a characteristic curve when plotted against the parameter p_2t_2/V_r, where p_2 is the combustion-chamber-inlet static pressure, t_2 is the combustion-chamber-inlet static temperature, and V_r is a reference velocity based on the maximum cross section of the combustion chamber (reference 1). Although this parameter does not account for the slight effect of fuel-air ratio on combustion efficiency, it serves as a convenient method for comparing the performance of different combustion chambers operating in the same general range of fuel-air ratios.

Combustion efficiency data obtained with the standard engine configuration are shown as a function of p_2t_2/V_r in figure 9(a). The data have been separated into ranges of fuel-air ratio to show the slight tendency of combustion efficiency to decrease with increasing values of fuel-air ratio. The variation of combustion efficiency with p_2t_2/V_r for the vaporizing combustor compares favorably with that of several atomizing type combustors used on various turbojet engines as shown in figure 9(b). Data for these atomizing combustors were obtained from references 1 and 2 and from unpublished data. Because of the range of operating conditions investigated, no data are available for the lower range of p_2t_2/V_r that would give a better comparison between the vaporizing and conventional type combustors. Because of the low reference velocities of approximately 70 to 85 feet per second and the somewhat higher compressor pressure ratio of this turbine-propeller engine than those of the turbojet engines used for comparison, combustion-chamber inlet conditions were favorable for combustion efficiencies in excess of 0.95 at an altitude of 40,000 feet over the range of engine speeds investigated.

The variation of combustion efficiency with corrected shaft horsepower at altitudes of 10,000 and 30,000 feet for the engine equipped with the 24-inch diameter tail pipe and with 22- and 20-inch diameter exhaust nozzles is shown in figure 10. Combustion efficiency was not affected noticeably by changing the exhaust nozzle diameter from 24 to 20 inches. Over the range of operating conditions investigated, the combustion efficiencies obtained for all four tail-pipe configurations varied from approximately 0.95 to 0.99.

Pressure Losses

The variation of combustion-chamber total-pressure-loss ratio $\Delta P/P$ with corrected shaft horsepower at various altitudes and corrected engine speeds is shown in figure 11 for the engine equipped with the standard tail pipe. At low values of corrected shaft horsepower, $\Delta P/P$ decreased as shaft horsepower was increased but tended to level off in the high shaft horsepower region. Varying the corrected engine speed from 7006 to 8706 rpm did not affect $\Delta P/P$ noticeably.

The effect of altitude on the variation of $\Delta P/P$ with corrected shaft horsepower is shown in figure 12. At low values of corrected shaft horsepower, $\Delta P/P$ increased slightly with increased altitude but in the region of high corrected shaft horsepower no appreciable altitude effect occurred. Changing the exhaust-nozzle-outlet area on the 24-inch diameter tail pipe did not result in a noticeable change in $\Delta P/P$, as shown in figure 13. Over the range of test conditions investigated, the value of $\Delta P/P$ varied from 0.037 to 0.043.

The effect of the combustion-chamber temperature ratio on the combustion-chamber total-pressure loss divided by the inlet impact pressure $\Delta P/q$ is shown in figure 14. The value of $\Delta P/q$ increased uniformly with an increase in the temperature ratio T_3/T_2 for all simulated flight conditions and tail-pipe configurations. The effect of altitude on $\Delta P/q$ at a given value of T_3/T_2 must be considered negligible as far as can be determined because of the amount of data scatter present. The value of $\Delta P/q$ was not affected by changing the exhaust-nozzle-outlet area on the 24-inch diameter tail pipe. Over th range of test conditions investigated, the value of $\Delta P/q$ varied fro approximately 1.7 to 2.4.

A theoretical line based on the sum of a friction-pressure-] ratio $\Delta P_f/q$ of 1.25 and a momentum-pressure-loss ratio of

$\Delta P_m/q = \left[(T_3/T_2)-1\right]$ is also shown in figure 14. Reasonably accurate predictions of combustion-chamber total-pressure loss can be made in this manner if the temperature ratio across the combustion chamber and the constant value of $\Delta P_f/q$ as determined from windmilling or "no-burning" data are known.

SUMMARY OF RESULTS

The following combustion-chamber performance results were obtained from an investigation of a Python turbine-propeller engine in the NACA Lewis altitude wind tunnel:

1. Combustion efficiency decreased slightly with increased altitude and increased fuel-air ratio but was not affected noticeably by changes in engine speed and exhaust-nozzle-outlet area. Over the range of test conditions investigated, the combustion efficiency varied from approximately 0.95 to 0.99.

2. At low values of corrected shaft horsepower, the combustion-chamber total-pressure-loss ratio $\Delta P/P$ decreased with increased shaft horsepower, but leveled off somewhat in the region of high corrected shaft horsepower. The value of $\Delta P/P$ increased slightly with increased altitude at low corrected shaft horsepowers. Changes in engine speed and exhaust-nozzle-outlet area had no apparent effect on $\Delta P/P$ and over the range of test conditions investigated, the value of $\Delta P/P$ varied from approximately 0.037 to 0.043.

3. The combustion-chamber total-pressure loss divided by the inlet impact pressure $\Delta P/q$ increased uniformly with increasing combustion-chamber temperature ratio T_3/T_2. At a given value of T_3/T_2, changes in altitude, engine speed, and exhaust-nozzle-outlet area had little if any effect on $\Delta P/q$. The value of $\Delta P/q$ varied from approximately 1.7 to 2.4 over the range of test conditions investigated.

Lewis Flight Propulsion Laboratory
National Advisory Committee for Aeronautics
Cleveland, Ohio

APPENDIX A

SYMBOLS

The following symbols are used in this report:

A	cross-sectional area, sq ft
C_T	thermal expansion ratio, ratio of hot exhaust-nozzle area to cold exhaust-nozzle area
f/a	fuel-air ratio
g	acceleration due to gravity, 32.2 ft/sec^2
ghp	gear horsepower
H	enthalpy, Btu/lb
J	mechanical equivalent of heat, 778 ft-lb/Btu
N	engine speed, rpm
P	total pressure, lb/sq ft absolute
$\frac{\Delta P}{P}$	combustion-chamber total-pressure-loss ratio, $(P_2-P_3)/P_2$; ratio of loss in total pressure across combustion chamber due to friction and heat addition to the total pressure at the combustion-chamber inlet
$\frac{\Delta P}{q}$	ratio of total-pressure loss across combustion chamber to combustion-chamber-inlet impact pressure, $(P_2-P_3)/(P_2-p_2)$
$\frac{\Delta P_f}{q}$	friction pressure-loss ratio; loss in total pressure across combustion chamber due to friction divided by the inlet impact pressure
$\frac{\Delta P_m}{q}$	momentum pressure-loss ratio; loss in total pressure across combustion chamber due to heat addition divided by the inlet impact pressure.
p	static pressure, lb/sq ft absolute
R	gas constant, 53.4 ft-lb/(lb)($^{\circ}$R)
shp	shaft horsepower

T total temperature, $^{\circ}R$

T_i indicated temperature, $^{\circ}R$

t static temperature, $^{\circ}R$

V velocity, ft/sec

V_r reference velocity based on maximum cross section of combustion chamber, ft/sec

W_a air flow, lb/sec

W_f fuel flow, lb/sec

W_g gas flow, lb/sec

α thermocouple impact recovery factor, 0.85

γ ratio of specific heats

δ_1 ratio of absolute total pressure at cowl inlet to absolute static pressure at NACA standard atmospheric sea-level conditions

θ_1 ratio of absolute total temperature at cowl inlet to absolute static temperature at NACA standard atmospheric sea-level conditions

η_b combustion efficiency

ρ density, slugs/cu ft

Subscripts:

1 cowl inlet

2 combustion-chamber inlet or compressor outlet

3 combustion-chamber outlet or turbine inlet

5 exhaust-nozzle inlet

a air

f fuel

n turbine-nozzle throat

APPENDIX B

METHODS OF CALCULATION

Total temperature. - Total temperatures were calculated from thermocouple-indicated temperatures by the equation 2253

$$T = \frac{T_i\left(\frac{P}{p}\right)^{\frac{\gamma-1}{\gamma}}}{1 + \alpha\left[\left(\frac{P}{p}\right)^{\frac{\gamma-1}{\gamma}} - 1\right]} \tag{B1}$$

Turbine-inlet temperature. - In order to calculate turbine-inlet temperature, the turbine power was assumed to equal the sum of the power absorbed by the compressor, the shaft horsepower measured by the torquemeter, and the power loss in the reduction gearing

$$(W_{g,3}\, H_3 - W_{g,5}\, H_5) = (W_{a,2}\, H_2 - W_{a,1}\, H_1) + \frac{550\ (shp+ghp)}{J}$$

Enthalpy at the turbine inlet was then

$$H_3 = \frac{(W_{a,5}\, H_{a,5} + W_f\, H_{f,5}) + (W_{a,2}\, H_2 - W_{a,1}\, H_1) + \frac{550\ (shp+ghp)}{J}}{W_{g,3}} \tag{B2}$$

Values for T_3 were then determined from a chart showing T_3 as a function of H_3 and fuel-air ratio (reference 3).

Gas flow. - Gas flow through the tail-pipe of the engine may be determined by use of pressure and temperature measurements at station 5 by the equation:

$$W_{g,5} = g\rho_5 C_T A_5 V_5 = p_5 C_T A_5 \sqrt{\frac{2\gamma_5 g}{(\gamma_5-1)Rt_5}\left[\left(\frac{P_5}{p_5}\right)^{\frac{\gamma_5-1}{\gamma_5}} - 1\right]} \tag{B3}$$

where C_T is the correction for thermal expansion of the exhaust nozzle. Gas flow values measured at station 5 showed excessive scatter because of the difficulty of measuring small impact pressures.

2253

Because the turbine nozzle was choked for the range of conditions investigated, the turbine-nozzle vena-contracta area was assumed constant and the following equation was used to obtain the final calculated gas flow

$$\frac{W_{g,n}}{A_n} = \frac{P_3}{\sqrt{T_3}} \sqrt{\frac{\gamma_3 g}{R}} \frac{1}{\left(\frac{\gamma_3+1}{2}\right)^{\frac{\gamma_3+1}{2(\gamma_3-1)}}} \qquad \text{(B4)}$$

The average turbine-nozzle vena-contracta area was calculated from equation (4) using the tail-pipe gas flows (station 5) and turbine-inlet total temperature based on tail-pipe gas flow. The turbine-inlet gas flow was determined from this average effective turbine-throat area and turbine-inlet temperature by equation (4). With this gas flow, a recalculation was made for turbine-inlet temperature, which showed a negligible change between the recalculated value and the original calculated temperature. The air flow at any station through the engine was calculated from $W_{g,n}$ by subtracting the fuel flow and by considering the various bleed-off air flows that were piped from the compressor.

Combustion efficiency. - The combustion efficiency is defined as the ratio of the actual increase in the enthalpy of the gas while passing through the combustion chamber to the theoretical increase in enthalpy that would result from complete combustion of the fuel charge. The increase in enthalpy through the combustion chamber is expressed as,

$$(W_{g,3}H_3 - W_{a,2}H_2) = W_{a,5}H_{a,5} + W_f H_{f,5} + W_{a,2}H_{a,2} - W_{a,1}H_{a,1} + \frac{550\ (shp+ghp)}{J} - W_{a,2}H_{a,2}$$

and the expression for combustion efficiency is, therefore,

$$\eta_b = \frac{W_{a,5}H_{a,5} + W_f H_{f,5} - W_{a,1}H_{a,1} + .707\ (shp+ghp)}{W_f \times 18,500}$$

where 18,500 Btu per pound of fuel is the lower heating value of the fuel.

REFERENCES

1. Childs, J. Howard: Preliminary Correlation of Efficiency of Aircraft Gas-Turbine Combustors for Different Operating Conditions. NACA RM E50F15, 1950.

2. Olson, Walter T., Childs, J. Howard, and Jonash, Edmund R.: Turbojet Combustor Efficiency at High Altitudes. NACA RM E50I07, 1950. 2253

3. Turner, L. Richard, and Lord, Albert M.: Thermodynamic Charts for the Computation of Combustion and Mixture Temperatures at Constant Pressure. NACA TN 1086, 1946.

TABLE I - PERFORMANCE DATA FOR

Run	Altitude (ft)	Ram-pressure ratio P_1/p_0	Tunnel static pressure p_0, (lb/sq ft abs.)	Engine speed, N (rpm)	Shaft horsepower shp	Compressor-inlet total pressure, P_1 (lb/sq ft abs.)	Compressor-inlet total temperature, T_1, (°R)	Combustion-chamber-inlet static pressure, p_2 (lb/sq ft abs.)	Combustion-chamber-inlet total pressure, P_2 (lb/sq ft abs.)	Combustion-chamber-inlet total temperature, T_2, (°R)	Combustion-chamber-outlet total pressure, P_3 (lb/sq ft abs.)	Combustion-chamber-outlet total temperature, T_3, (°R)[a]	Exhaust-nozzle-inlet total temperature, T_5, (°R)
23-inch diameter tail pipe with no exhaust nozzle (standard configuration)													
1	10,000	1.026	1449	6805	307	1487	487	5097	5223	754	5007	1280	990
2		1.027	1454	6805	686	1493	489	5352	5468	764	5254	1425	1106
3		1.026	1452	6805	965	1490	490	5425	5531	766	5323	1530	1192
4		1.026	1455	6805	1148	1493	491	5565	5671	773	5474	1618	1264
5		1.027	1447	6805	1235	1486	490	5543	5645	773	5437	1659	1292
6		1.025	1439	7205	302	1475	491	5530	5671	788	5435	1302	989
7		1.025	1452	7205	889	1489	487	5928	6058	792	5818	1492	1134
8		1.026	1448	7205	1314	1485	486	6158	6279	799	6043	1636	1249
9		1.025	1452	7205	1524	1489	490	6222	6339	805	6101	1700	1322
10		1.025	1453	7205	1658	1489	490	6278	6392	806	6155	1778	1358
11		1.025	1451	7406	289	1487	487	5845	5996	797	5742	1301	978
12		1.026	1449	7406	1045	1486	493	6185	6317	816	6072	1542	1166
13		1.025	1457	7408	1641	1494	490	6527	6652	820	6399	1738	1313
14		1.026	1444	7406	1852	1481	487	6615	6738	817	6484	1813	1374
15		1.026	1451	7406	1978	1489	488	6688	6809	821	6557	1863	1416
16		1.026	1452	7406	2041	1490	480	6822	6945	816	6685	1834	1385
17		1.027	1440	7606	241	1479	482	6088	6250	806	5985	1291	960
18		1.026	1448	7606	1165	1485	486	6572	6713	822	6450	1555	1160
19		1.026	1451	7606	1924	1489	488	6947	7077	833	6815	1790	1341
20		1.026	1448	7606	2139	1486	484	7066	7199	832	6925	1854	1391
21		1.026	1450	7606	2289	1488	485	7111	7240	835	6969	1909	1435
22		1.027	1446	7806	316	1485	490	6324	6488	832	6213	1362	1014
23		1.027	1449	7806	1295	1488	477	6978	7126	830	6851	1585	1170
24		1.026	1449	7806	1317	1487	484	6907	7054	835	6779	1599	1186
25		1.026	1451	7806	2085	1489	488	7234	7373	850	7095	1819	1352
26		1.026	1456	7806	2085	1494	494	7224	7348	858	7073	1849	1380
27		1.026	1450	7806	2294	1488	480	7400	7538	842	7254	1872	1392
28		1.027	1456	7806	2316	1495	482	7459	7600	846	7315	1887	1405
29		1.026	1437	7806	2316	1475	486	7329	7465	851	7184	1889	1410
30		1.026	1453	7806	2491	1491	489	7492	7627	860	7341	1983	1486
31		1.028	1456	8006	410	1497	479	6777	6953	831	6662	1373	1012
32		1.028	1448	8006	1419	1488	484	7260	7417	855	7130	1638	1206
33		1.027	1455	8006	2139	1495	483	7674	7826	863	7533	1827	1352
34		1.028	1454	8006	2398	1494	485	7755	7905	868	7608	1885	1389
35		1.028	1451	8006	2578	1492	485	7910	8063	869	7762	1958	1452
36		1.027	1458	8006	2724	1498	483	7910	8061	868	7755	2017	1502
37		1.027	1456	8006	2735	1496	481	7991	8142	865	7832	1976	1460
38		1.028	1446	8006	2769	1486	486	7790	7931	870	7637	2067	1549
39	20,000	1.026	970	6805	255	995	454	3623	3708	722	3557	1251	962
40		1.027	964	6805	582	990	455	3767	3844	731	3691	1430	1100
41		1.028	967	6805	720	994	454	3852	3928	732	3779	1508	1159
42		1.028	973	6805	816	1000	455	3916	3986	736	3838	1568	1208
43		1.025	965	7205	249	989	454	3939	4033	753	3865	1286	973
44		1.026	972	7205	773	997	456	4230	4318	764	4149	1519	1145
45		1.027	971	7205	1134	997	455	4435	4513	769	4346	1705	1296
46		1.026	963	7205	1246	988	458	4408	4482	775	4318	1780	1356
47		1.027	964	7205	1262	990	458	4417	4502	775	4330	1780	1364
48		1.027	966	7205	1308	992	456	4443	4519	773	4353	1822	1392
49		1.027	968	7205	1345	994	454	4514	4591	772	4423	1812	1377
50		1.025	973	7406	272	997	452	4169	4251	761	4095	1286	961
51		1.027	966	7406	883	992	454	4462	4555	776	4378	1562	1167
52		1.027	971	7406	1303	997	450	4727	4811	780	4633	1728	1288
53		1.026	965	7406	1444	990	452	4741	4825	785	4648	1815	1364
54		1.027	971	7406	1556	997	454	4805	4887	789	4704	1868	1405
55		1.027	968	7606	296	994	455	4359	4464	781	4280	1320	979
56		1.027	966	7606	949	992	455	4704	4800	793	4612	1583	1172
57		1.027	977	7606	1392	1003	457	4969	5058	802	4870	1760	1305
58		1.027	969	7606	1565	995	456	5016	5106	804	4913	1832	1362
59		1.027	979	7606	1565	1005	461	5015	5105	812	4913	1854	1384
60		1.027	970	7606	1701	996	456	5088	5176	809	4985	1911	1427
61		1.026	975	7806	292	1000	452	4513	4623	793	4431	1344	989
62		1.027	969	7808	1024	995	454	4906	5005	807	4808	1597	1175
63		1.028	971	7806	1522	998	453	5179	5277	813	5075	1775	1309
64		1.027	976	7806	1545	1002	457	5184	5280	819	5080	1816	1345
65		1.028	976	7806	1740	1003	457	5303	5398	821	5189	1907	1410
66		1.028	969	7808	1891	996	458	5368	5460	827	5251	1988	1479
67		1.027	972	8006	361	998	454	4678	4788	812	4587	1417	1041

[a]Calculated temperature.
[b]Determined from air flow calculated at station 3.
[c]Corrected to NACA standard sea-level static conditions.

NACA

[redacted]

PYTHON TURBINE-PROPELLER ENGINE

Fuel flow, $W_f \times 3600$ (lb/hr)	Engine-inlet air flow $W_{a,1}$, (lb/sec)[b]	Combustion-chamber air flow, $W_{a,3}$, (lb/sec)	Exhaust-nozzle-inlet air flow, $W_{a,5}$, (lb/sec)[b]	Fuel-air ratio (W_f/W_a), f/a	Combustion efficiency, η_b	Combustion-chamber total-pressure-loss ratio, $\Delta P/P$	Ratio of combustion-chamber total-pressure loss to inlet impact-pressure, $\Delta P/q$	Combustion-chamber temperature ratio T_3/T_2	Corrected engine speed, $N/\sqrt{\theta_1}$, (rpm)[c]	Corrected shaft horsepower shp/$\delta_1\sqrt{\theta_1}$[c]	Run
23-inch diameter tail pipe with no exhaust nozzle (standard configuration)											
810	32.22	31.96	32.07	.0070	1.026	.0414	1.714	1.698	7023	451	1
1050	31.91	31.64	31.75	.0091	1.000	.0391	1.845	1.865	7009	1002	2
1220	31.10	30.82	30.93	.0109	.986	.0376	1.962	1.997	7002	1410	3
1360	31.05	30.76	30.88	.0122	.986	.0347	1.858	2.093	6996	1673	4
1400	30.41	30.12	30.24	.0128	.984	.0368	2.039	2.146	7002	1809	5
875	34.76	34.40	34.52	.0070	1.002	.0416	1.674	1.652	7407	445	6
1220	34.53	34.16	34.28	.0098	.992	.0396	1.846	1.884	7436	1303	7
1470	34.14	33.74	33.87	.0120	.996	.0376	1.950	2.048	7443	1934	8
1600	33.73	33.34	33.47	.0132	.997	.0375	2.034	2.112	7414	2228	9
1675	33.22	32.83	32.96	.0140	.992	.0371	2.079	2.206	7414	2424	10
910	36.71	36.36	36.48	.0039	.997	.0424	1.682	1.637	7543	425	11
1310	35.41	35.04	35.17	.0103	.995	.0388	1.856	1.890	7599	1527	12
1680	34.97	34.57	34.71	.0132	.993	.0380	2.024	2.120	7621	2391	13
1810	34.62	34.22	34.36	.0145	.986	.0377	2.065	2.219	7643	2732	14
1880	34.52	34.12	34.26	.0151	.995	.0370	2.083	2.269	7643	2900	15
1900	35.48	35.07	35.21	.0149	.989	.0374	2.114	2.248	7702	3015	16
900	38.42	38.06	38.19	.0065	1.019	.0424	1.635	1.602	7895	358	17
1420	37.42	37.04	37.18	.0105	.981	.0392	1.865	1.892	7857	1715	18
1820	36.65	36.25	36.39	.0138	.994	.0370	2.015	2.149	7849	2821	19
1975	36.50	36.09	36.24	.0150	.986	.0381	2.060	2.228	7872	3153	20
2060	36.18	35.77	35.92	.0158	.988	.0374	2.101	2.286	7865	3365	21
1010	38.74	38.40	38.53	.0072	1.011	.0424	1.677	1.637	8032	463	22
1500	39.34	38.96	39.11	.0106	1.004	.0386	1.858	1.910	8142	1920	23
1510	38.74	38.37	38.51	.0108	.997	.0390	1.871	1.915	8079	1940	24
1920	37.81	37.41	37.56	.0141	.992	.0377	2.000	2.140	8056	3057	25
1940	37.35	36.95	37.10	.0144	.996	.0374	2.218	2.155	8001	3025	26
2050	38.04	37.64	37.79	.0150	.998	.0377	2.058	2.223	8118	3393	27
2080	38.21	37.80	37.96	.0151	1.000	.0375	2.021	2.230	8103	3402	28
2080	37.47	37.07	37.22	.0154	.984	.0376	2.066	2.220	8064	3432	29
2240	37.30	36.90	37.06	.0167	.987	.0375	2.119	2.306	8040	3642	30
1125	41.34	41.00	41.14	.0076	.993	.0419	1.653	1.652	8334	603	31
1645	40.19	39.83	39.98	.0114	.984	.0387	1.828	1.916	8286	2089	32
2055	39.99	39.60	39.76	.0143	.981	.0374	1.928	2.117	8302	3138	33
2170	39.71	39.32	39.48	.0152	.978	.0376	1.980	2.172	8278	3511	34
2330	39.68	39.27	39.44	.0163	.978	.0373	1.967	2.253	8278	3779	35
2420	39.03	38.60	38.77	.0172	.983	.0380	2.026	2.324	8302	3991	36
2400	39.84	39.43	39.60	.0167	.975	.0381	2.053	2.284	8318	4018	37
2460	37.92	37.50	37.66	.0180	.985	.0371	2.085	2.376	8270	4073	38
595	23.15	22.98	23.06	.0071	1.005	.0407	1.776	1.733	7275	580	39
800	22.33	22.16	22.24	.0100	.978	.0398	1.987	1.956	7268	1328	40
875	22.23	22.05	22.13	.0109	.989	.0379	1.961	2.060	7275	1639	41
940	22.11	21.93	22.01	.0118	.988	.0371	2.114	2.130	7268	1844	42
645	24.79	24.61	24.69	.0072	1.010	.0417	1.787	1.708	7702	570	43
925	24.33	24.13	24.22	.0106	1.000	.0391	1.920	1.988	7688	1750	44
1150	23.93	23.72	23.81	.0134	1.002	.0370	2.141	2.217	7695	2570	45
1225	23.22	23.01	23.10	.0147	.984	.0366	2.216	2.297	7666	2840	46
1250	23.19	22.98	23.07	.0150	.973	.0382	2.024	2.310	7666	2870	47
1270	23.11	22.90	22.99	.0153	.990	.0367	2.184	2.357	7688	2977	48
1285	23.54	23.33	23.42	.0152	.986	.0366	2.182	2.347	7702	3061	49
680	26.27	26.07	26.16	.0072	1.001	.0367	1.902	1.690	7932	618	50
1010	25.28	25.07	25.16	.0111	.993	.0389	1.903	2.013	7917	2013	51
1250	25.32	25.09	25.19	.0137	.982	.0370	2.119	2.215	7954	2970	52
1345	24.73	24.50	24.60	.0151	.982	.0367	2.107	2.312	7932	3305	53
1415	24.64	24.41	24.51	.0160	.978	.0374	2.232	2.368	7917	3529	54
717	27.10	26.89	26.98	.0074	1.012	.0412	1.752	1.690	8123	673	55
1065	26.45	26.22	26.32	.0112	.993	.0392	1.958	1.996	8123	2162	56
1315	26.35	26.11	26.21	.0139	.988	.0372	2.112	2.195	8108	3131	57
1420	26.02	25.78	25.88	.0152	.979	.0378	2.144	2.279	8116	3553	58
1430	25.85	25.61	25.71	.0154	.982	.0376	2.133	2.283	8070	3495	59
1515	25.82	25.56	25.67	.0163	.984	.0369	2.170	2.362	8116	3854	60
750	27.78	27.57	27.66	.0075	1.012	.0415	1.745	1.695	8360	662	61
1125	27.46	27.22	27.32	.0114	.986	.0394	1.990	1.979	8345	2329	62
1385	27.36	27.10	27.21	.0141	.986	.0383	2.061	2.183	8360	3456	63
1420	27.04	26.78	26.89	.0146	.989	.0379	2.083	2.217	8321	3478	64
1555	26.90	26.63	26.74	.0161	.982	.0387	2.200	2.323	8321	3913	65
1675	26.59	26.32	26.43	.0175	.974	.0383	2.272	2.404	8329	4285	66
840	27.97	27.74	27.84	.0083	1.002	.0420	1.827	1.745	8558	818	67

NACA

TABLE I - PERFORMANCE DATA FOR PYTHON

Run	Altitude (ft)	Ram-pressure ratio P_1/p_0	Tunnel static pressure p_0, (lb/sq ft abs.)	Engine speed, N (rpm)	Shaft horsepower shp	Compressor-inlet total pressure, P_1 (lb/sq ft abs.)	Compressor-inlet total temperature, T_1, (°R)	Combustion-chamber-inlet static pressure, p_2 (lb/sq ft abs.)	Combustion-chamber-inlet total pressure, P_2 (lb/sq ft abs.)	Combustion-chamber-inlet total temperature, T_2, (°R)	Combustion-chamber-outlet total pressure, P_3 (lb/sq ft abs.)	Combustion-chamber-outlet total temperature, T_3, (°R)[a]	Exhaust-nozzle-inlet total temperature, T_5, (°R)
23-inch diameter tail pipe with no exhaust nozzle (standard configuration)													
68	20,000	1.028	968	8006	469	995	451	4758	4871	808	4675	1420	1036
69		1.027	969	8006	1146	995	450	5152	5260	819	5059	1669	1221
70		1.027	968	8006	1204	994	455	5119	5222	827	5017	1703	1252
71		1.028	969	8006	1556	996	450	5375	5480	825	5272	1791	1314
72		1.028	975	8006	1699	1002	455	5442	5531	834	5316	1885	1389
73		1.027	971	8006	1790	997	449	5509	5613	829	5404	1903	1404
74		1.028	973	8006	1883	1000	456	5532	5620	839	5407	1975	1461
75		1.028	975	8006	1922	1002	451	5619	5725	837	5505	1969	1457
76		1.029	965	8006	2013	993	456	5575	5673	844	5456	2062	1539
77	30,000	1.025	629	6805	282	645	439	2521	2573	713	2466	1327	1019
78		1.027	624	6805	366	641	438	2555	2607	720	2501	1399	1068
79		1.027	630	6805	481	647	440	2613	2664	725	2532	1492	1138
80		1.026	624	6805	551	640	436	2632	2681	723	2578	1537	1173
81		1.027	623	6805	580	640	441	2642	2689	729	2585	1583	1207
82		1.026	623	7205	288	639	438	2719	2780	740	2667	1349	1011
83		1.027	623	7505	573	640	436	2905	2961	753	2848	1528	1136
84		1.027	625	7205	761	642	435	2991	3047	755	2933	1639	1221
85		1.023	626	7205	824	642	435	3033	3087	758	2985	1598	1269
86		1.027	626	7205	870	643	437	3027	3080	761	2965	1741	1306
87		1.027	623	7405	302	640	437	2862	2927	760	2803	1371	1016
88		1.027	626	7406	664	643	438	3022	3083	764	2965	1567	1167
89		1.026	625	7406	889	641	436	3142	3200	772	3081	1717	1272
90		1.027	626	7406	995	643	437	3153	3205	774	3088	1815	1355
91		1.025	628	7406	1052	644	437	3219	3273	781	3149	1866	1391
92		1.026	618	7606	276	634	437	2916	2975	767	2858	1362	1006
93		1.027	622	7606	742	639	440	3142	3203	785	3081	1631	1203
94		1.025	628	7606	1016	644	444	3288	3346	795	3221	1807	1340
95		1.024	630	7606	1114	645	438	3424	3479	800	3349	1889	1399
96		1.027	624	7606	1173	641	439	3410	3465	799	3337	1925	1434
97		1.027	619	7806	336	636	436	3016	3087	784	2958	1426	1044
98		1.027	623	7806	773	640	437	3308	3372	800	3241	1660	1211
99		1.027	625	7806	1077	642	437	3469	3529	806	3395	1829	1340
100		1.027	626	7806	1215	643	438	3543	3603	813	3470	1938	1437
101		1.026	627	7806	1287	643	438	3561	3617	817	3482	2023	1505
102		1.026	621	8006	266	637	436	3070	3139	798	3007	1430	1052
103		1.027	629	8006	306	646	443	3125	3196	808	3063	1459	1071
104		1.029	623	8006	824	641	440	3392	3457	817	3324	1716	1256
105		1.027	627	8006	869	644	436	3431	3496	814	3358	1732	1262
106		1.027	624	8006	1107	641	441	3566	3626	825	3486	1881	1382
107		1.027	628	8006	1173	645	437	3587	3649	823	3508	1925	1420
108		1.027	631	8006	1237	648	442	3663	3729	828	3585	1858	1444
109		1.027	626	8006	1303	643	438	3656	3715	827	3574	2007	1486
110		1.029	625	8006	1345	643	441	3705	3765	833	3615	2040	1510
111		1.027	626	8006	1376	643	437	3734	3795	831	3651	2081	1545
112	40,000	1.030	394	7406	268	406	444	1801	1836	772	1763	1502	1122
113		1.028	393	7406	415	404	442	1861	1889	773	1816	1663	1251
114		1.028	394	7406	491	405	442	1900	1934	776	1857	1741	1310
115		1.026	390	7606	253	400	439	1862	1901	783	1820	1522	1131
116		1.025	398	7606	426	408	439	1983	2019	791	1937	1674	1243
117		1.028	391	7606	515	402	442	2000	2036	800	1956	1763	1308
118		1.030	394	7606	593	406	438	2042	2077	799	1998	1832	1361
119		1.028	391	7606	628	402	438	2061	2095	802	2013	1889	1413
120		1.023	395	7806	237	404	438	1934	1975	797	1890	1512	1120
121		1.020	391	7806	332	399	437	2136	2171	809	2087	1850	1365
122		1.025	394	7806	699	404	436	2155	2196	812	2113	1928	1425
123		1.025	397	7806	745	407	434	2195	2233	814	2152	1979	1470
124		1.026	389	8006	232	399	446	1952	1995	813	1908	1523	1121
125		1.028	396	8006	300	407	440	2014	2059	818	1973	1587	1166
126		1.026	390	8006	507	400	439	2089	2130	817	2042	1752	1290
127		1.028	387	8006	526	398	441	2105	2144	826	2060	1788	1310
128		1.028	392	8006	671	403	441	2204	2244	824	2157	1909	1410
129		1.028	386	8006	678	397	439	2188	2224	831	2138	1930	1419
130		1.026	387	8006	746	397	438	2235	2274	834	2184	2003	1487
131		1.025	396	8006	764	406	443	2257	2287	832	2198	2017	1498
132		1.026	390	8006	738	400	442	2247	2282	839	2196	2042	1515
133		1.025	396	8006	799	409	441	2284	2320	840	2231	2049	1517

[a]Calculated temperature.

[b]Determined from air flow calculated at station 3.

[c]Corrected to NACA standard sea-level static conditions.

[redacted]

2253

TURBINE-PROPELLER ENGINE - Continued

Fuel flow, $W_f \times 3600$ (lb/hr)	Engine-inlet air flow $W_{a,1}$, (lb/sec)[b]	Combustion-chamber air flow, $W_{a,3}$, (lb/sec)	Exhaust-nozzle-inlet air flow, $W_{a,5}$, (lb/sec)[b]	Fuel-air ratio (W_f/W_a), f/a	Combustion efficiency, η_b	Combustion-chamber total-pressure-loss ratio, $\Delta P/P$	Ratio of combustion-chamber total-pressure loss to inlet impact pressure, $\Delta P/q$	Combustion-chamber temperature ratio T_3/T_2	Corrected engine speed, $N/\sqrt{\theta_1}$, (rpm)[c]	Corrected shaft horsepower shp/$\delta_1\sqrt{\theta_1}$[c]	Run
23-inch diameter tail pipe with no exhaust nozzle (standard configuration)											
885	28.43	28.21	28.31	.0086	.983	.0402	1.735	1.757	8590	1070	68
1265	28.19	27.95	28.06	.0125	.970	.0382	1.861	2.038	8598	2617	69
1265	27.67	27.41	27.52	.0127	.987	.0393	1.990	2.059	8550	2738	70
1475	28.24	28.00	28.11	.0145	.963	.0380	1.981	2.171	8598	3549	71
1550	27.74	27.47	27.58	.0155	.984	.0389	2.416	2.260	8550	3833	72
1610	28.01	27.76	27.87	.0160	.982	.0372	2.010	2.296	8606	4083	73
1680	27.50	27.22	27.33	.0170	.981	.0379	2.420	2.354	8542	4252	74
1730	28.02	27.76	27.88	.0172	.972	.0384	2.075	2.352	8590	4355	75
1810	27.10	26.81	26.93	.0186	.973	.0383	2.214	2.443	8542	4578	76
472	15.58	15.43	15.48	.0084	.999	.0416	2.058	1.853	7397	934	77
525	15.35	15.19	15.24	.0095	.985	.0407	2.038	1.943	7411	1316	78
595	15.19	15.03	15.08	.0109	.976	.0383	2.000	2.058	7390	1708	79
635	15.04	14.88	14.93	.0117	.970	.0384	2.102	2.126	7424	1987	80
670	14.83	14.67	14.72	.0125	.951	.0387	2.213	2.171	7383	2080	81
500	16.72	16.55	16.61	.0083	1.007	.0406	1.852	1.823	7861	1040	82
665	16.68	16.51	16.57	.0111	.973	.0382	2.018	2.029	7861	2067	83
755	16.53	16.36	16.42	.0129	.966	.0374	2.036	2.171	7868	2739	84
805	16.49	16.32	16.3e	.0136	.981	.0330	1.889	2.240	7868	2966	85
840	16.16	15.99	16.05	.0144	.968	.0373	2.170	2.288	7853	3121	86
525	17.39	17.23	17.29	.0084	1.006	.0424	1.908	1.804	8073	1088	87
720	17.11	16.94	17.00	.0117	.967	.0383	1.934	2.051	8065	2380	88
845	16.92	16.74	16.81	.0139	.967	.0372	2.052	2.224	8080	3201	89
910	16.45	16.28	16.35	.0154	.975	.0365	2.250	2.345	8073	3569	90
960	16.52	16.34	16.41	.0161	.971	.0379	2.296	2.389	8073	3768	91
540	17.80	17.64	17.70	.0084	.972	.0393	1.983	1.776	8291	1004	92
774	17.40	17.23	17.30	.0124	.972	.0381	2.000	2.078	8260	2668	93
935	17.20	17.02	17.09	.0151	.966	.0374	2.155	2.273	8222	3609	94
1020	17.46	17.28	17:35	.0162	.970	.0374	2.364	2.361	8283	3980	95
1050	17.22	17.03	17.10	.0169	.970	.0369	2.327	2.409	8268	4209	96
570	17.97	17.81	17.87	.0088	1.007	.0418	1.817	1.819	8516	1220	97
815	18.12	17.95	18.02	.0125	.975	.0388	2.047	2.075	8509	2786	98
983	17.99	17.82	17.89	.0152	.971	.0380	2.233	2.269	8509	3870	99
1095	17.83	17.65	17.72	.0171	.964	.0369	2.217	2.384	8501	4355	100
1160	17.46	17.28	17.35	.0185	.962	.0373	2.411	2.476	8501	4613	101
575	18.22	18.08	18.14	.0088	1.007	.0421	1.913	1.792	8735	964	102
610	18.35	18.21	18.28	.0092	.984	.0416	1.873	1.806	8670	1086	103
870	18.24	18.09	18.16	.0133	.971	.0385	2.046	2.100	8695	2954	104
885	18.33	18.17	18.24	.0134	.977	.0395	2.123	2.128	8735	3115	105
1045	18.17	18.02	18.09	.0160	.962	.0386	2.333	2.280	8687	3965	106
1085	18.08	17.91	17.98	.0167	.968	.0386	2.274	2.339	8727	4195	107
1130	18.30	18.13	18.21	.0172	.964	.0386	2.182	2.365	8679	4378	108
1170	18.01	17.83	17.91	.0180	.962	.0380	2.390	2.427	8719	4670	109
1230	18.02	17.85	17.93	.0190	.943	.0398	2.500	2.449	8687	4803	110
1265	18.02	17.83	17.91	.0195	.949	.0379	2.361	2.504	8727	4936	111
390	10.41	10.31	10.35	.0104	.975	.0398	2.086	1.946	8006	1510	112
470	10.15	10.04	10.08	.0129	.983	.0386	2.607	2.151	8028	2356	113
520	10.13	10.02	10.06	.0143	.969	.0398	2.265	2.244	8028	2781	114
400	10.67	10.57	10.61	.0104	.987	.0426	2.077	1.944	8268	1455	115
490	10.78	10.68	10.72	.0126	.990	.0406	2.278	2.116	8268	2401	116
550	10.58	10.48	10.52	.0144	.958	.0393	2.222	2.204	8245	2939	117
590	10.58	10.48	10.52	.0155	.963	.0380	2.257	2.293	8283	3366	118
620	10.48	10.38	10.42	.0164	.962	.0391	2.412	2.355	8283	3588	119
400	11.13	11.03	11.07	.0100	1.002	.0430	2.073	1.897	8501	1352	120
630	10.98	10.89	10.93	.0159	.948	.0387	2.400	2.287	8509	3653	121
670	10.88	10.77	10.81	.0171	.948	.0378	2.024	2.374	8516	3995	122
700	10.93	10.81	10.86	.0178	.959	.0363	2.132	2.431	8540	4238	123
410	11.17	11.08	11.12	.0102	.975	.0436	2.023	1.873	8638	1328	124
450	11.30	11.21	11.25	.0111	.981	.0418	1.911	1.940	8695	1694	125
560	11.07	10.97	11.01	.0141	.956	.0413	2.146	2.144	8703	2915	126
570	11.03	10.95	10.99	.0144	.962	.0392	2.154	2.165	8687	3034	127
660	11.17	11.06	11.11	.0164	.961	.0388	2.175	2.317	8687	3823	128
665	10.99	10.89	10.94	.0168	.954	.0387	2.389	2.323	8703	3928	129
725	11.00	10.90	10.95	.0183	.943	.0396	2.308	2.402	8719	4330	130
720	11.04	10.93	10.98	.0181	.964	.0389	2.967	2.424	8662	4308	131
745	10.94	10.84	10.89	.0189	.942	.0377	2.457	2.434	8679	4404	132
755	11.10	10.99	11.04	.0189	.949	.0384	2.472	2.439	8687	4518	133

NACA

[redacted]

2253

TABLE I - PERFORMANCE DATA FOR PYTHON

Run	Altitude (ft)	Ram-pressure ratio P_1/p_0	Tunnel static pressure p_0, (lb/sq ft abs.)	Engine speed, N (rpm)	Shaft horsepower shp	Compressor-inlet total pressure, P_1 (lb/sq ft abs.)	Compressor-inlet total temperature, T_1, (°R)	Combustion-chamber-inlet static pressure, p_2 (lb/sq ft abs.)	Combustion-chamber-inlet total pressure, P_2 (lb/sq ft abs.)	Combustion-chamber-inlet total temperature, T_2, (°R)	Combustion-chamber-outlet total pressure, P_3 (lb/sq ft abs.)	Combustion-chamber-outlet total temperature, T_3, (°R)[a]	Exhaust-nozzle inlet total temperature, T_5, (°R)
24-inch diameter tail pipe with no exhaust nozzle													
134	10,000	1.025	1449	7205	322	1485	485	5445	5580	776	5340	1298	989
135		1.025	1443	7205	916	1480	484	5775	5900	785	5657	1477	1126
136		1.025	1451	7205	1285	1487	487	5937	6051	791	5811	1620	1237
137		1.025	1450	7205	1427	1493	486	6025	6138	791	5899	1672	1278
138		1.025	1453	7205	1560	1490	488	6076	6186	796	5949	1734	1333
139		1.025	1452	7406	325	1489	487	5746	5888	793	5635	1313	989
140		1.026	1446	7606	357	1483	482	6064	6217	802	5944	1320	983
141		1.025	1453	7606	380	1490	484	6043	6192	804	5924	1328	993
142		1.025	1455	7606	1130	1492	488	6428	6567	820	6295	1545	1157
143		1.025	1447	7606	1668	1483	486	6672	6800	824	6532	1714	1283
144		1.025	1453	7606	1948	1490	489	6780	6902	831	6635	1828	1376
145		1.025	1452	7606	2115	1489	488	6865	6988	832	6717	1875	1417
146		1.025	1454	7806	366	1491	488	6251	6411	824	6132	1358	1008
147		1.023	1457	7806	1353	1490	494	6699	6836	844	6558	1625	1217
148		1.025	1452	7806	2021	1489	494	7033	7164	853	6888	1835	1373
149		1.025	1454	7806	2275	1491	484	7277	7405	843	7120	1889	1413
150		1.026	1446	7806	2275	1484	485	7181	7307	845	7024	1913	1433
151		1.025	1453	7806	2297	1490	484	7272	7404	842	7116	1869	1413
152		1.026	1450	7806	2463	1488	493	7245	7368	856	7088	1982	1494
153		1.026	1451	8006	460	1489	489	6555	6716	841	6425	1395	1029
154		1.026	1448	8006	1387	1486	493	6965	7115	859	6826	1646	1221
155		1.027	1448	8006	2538	1487	492	7529	7659	871	7368	1990	1484
156		1.027	1451	8006	2741	1490	492	7674	7807	875	7507	2054	1536
157	30,000	1.025	628	7205	272	644	432	2726	2790	739	2671	1317	975
158		1.024	627	7205	599	642	435	2877	2933	747	2815	1522	1131
159		1.024	627	7205	834	642	434	2980	3033	754	2918	1685	1258
160		1.025	631	7205	896	647	435	3033	3082	756	2967	1744	1313
161		1.026	627	7205	937	643	435	3018	3069	759	2953	1779	1338
162		1.026	624	7606	357	640	435	2935	3000	768	2873	1393	1024
163		1.026	625	7606	820	641	435	3204	3265	780	3134	1653	1213
164		1.026	627	7606	1069	643	435	3330	3386	789	3255	1822	1350
165		1.024	627	7606	1120	642	436	3343	3400	791	3268	1871	1392
166		1.026	627	7606	1211	643	436	3390	3445	796	3314	1954	1456
167		1.025	629	7806	283	645	437	3002	3071	785	2956	1383	1012
168		1.025	630	7806	768	646	437	3291	3356	796	3222	1629	1185
169		1.024	626	7806	1105	641	437	3451	3510	806	3374	1836	1350
170		1.027	626	7806	1198	643	437	3506	3564	809	3429	1915	1412
171		1.027	627	7806	1270	644	439	3551	3608	816	3469	1988	1473
172		1.026	625	8006	302	641	436	3113	3160	798	3024	1452	1045
173		1.025	628	8006	845	644	437	3391	3454	808	3316	1693	1233
174		1.027	624	8006	1155	641	438	3539	3599	816	3461	1871	1376
175		1.027	624	8006	1291	641	438	3631	3673	822	3535	1975	1459
176		1.025	629	8006	1359	645	439	3689	3748	830	3608	2062	1535
177	40,000	1.023	391	7606	141	400	438	1777	1819	775	1738	1324	969
178		1.026	389	7606	334	399	437	1889	1927	783	1846	1537	1124
179		1.031	390	7606	504	402	441	1989	2026	794	1949	1742	1299
180		1.028	390	7606	582	401	436	2057	2092	796	2009	1838	1373
181		1.023	393	8006	232	402	433	1967	2010	805	1925	1514	1110
182		1.028	391	8006	472	402	436	2145	2169	817	2080	1733	1277
183		1.031	394	8006	671	406	437	2199	2239	822	2150	1875	1379
184		1.031	389	8006	683	401	433	2192	2231	819	2143	1900	1397
185		1.028	391	8006	764	402	436	2286	2323	823	2232	2032	1519
24-inch diameter tail pipe with 22-inch diameter exhaust nozzle													
186	10,000	1.026	1449	7606	858	1487	485	6282	6412	815	6146	1511	1159
187		1.026	1446	7606	1475	1483	487	6547	6670	826	6406	1721	1303
188		1.025	1453	7606	1733	1490	488	6673	6791	830	6525	1810	1374
189		1.026	1451	7606	1916	1489	489	6764	6883	834	6613	1884	1433
190		1.026	1443	7806	881	1481	484	6533	6675	829	6423	1518	1136
191		1.026	1452	7806	1657	1490	489	6915	7042	844	6760	1752	1321
192		1.025	1451	7806	1977	1488	486	7105	7232	845	6950	1864	1399
193		1.026	1450	7806	2265	1488	487	7234	7354	851	7069	1972	1488
194		1.026	1452	8006	2266	1490	487	7503	7631	862	7336	1941	1456
195		1.027	1454	8006	2266	1493	499	7412	7533	880	7246	2019	1529
196		1.027	1456	8006	2572	1495	493	7617	7737	875	7441	2076	1570
197	30,000	1.026	627	7606	471	643	441	3011	3076	778	2947	1506	1122
198		1.027	628	7606	830	645	442	3213	3270	789	3140	1740	1297
199		1.029	627	7606	989	645	441	3296	3353	793	3225	1855	1395

[a]Calculated temperature.

[b]Determined from air flow calculated at station 3.

[c]Corrected to NACA standard sea-level static conditions.

NACA

2253

TURBINE-PROPELLER ENGINE - Continued

Fuel flow, $W_f \times 3600$ (lb/hr)	Engine-inlet air flow $W_{a,1}$, (lb/sec)[b]	Combustion-chamber air flow, $W_{a,3}$, (lb/sec)	Exhaust-nozzle-inlet air flow, $W_{a,5}$, (lb/sec)[b]	Fuel-air ratio (W_f/W_a), f/a	Combustion efficiency, η_b	Combustion-chamber total-pressure-loss ratio, $\Delta P/P$	Ratio of combustion-chamber total-pressure loss to inlet impact pressure, $\Delta P/q$	Combustion-chamber temperature ratio T_3/T_2	Corrected engine speed, $N/\sqrt{\theta_1}$, (rpm)[c]	Corrected shaft horsepower $shp/\delta_1\sqrt{\theta_1}$[c]	Run
24-inch diameter tail pipe with no exhaust nozzle											
880	34.20	33.83	33.94	.0071	.992	.0430	1.778	1.673	7450	474	134
1210	33.77	33.39	33.51	.0100	.972	.0412	1.944	1.882	7457	1357	135
1430	33.01	32.62	32.73	.0120	.973	.0397	2.105	2.048	7436	1888	136
1520	32.94	32.55	32.68	.0128	.975	.0389	2.115	2.114	7443	2089	137
1610	32.57	32.17	32.30	.0137	.977	.0383	2.155	2.178	7436	2285	138
910	35.87	35.49	35.61	.0070	1.003	.0430	1.782	1.656	7643	476	139
970	37.73	37.35	37.48	.0071	.993	.0439	1.784	1.646	7895	529	140
985	37.50	37.12	37.25	.0073	.984	.0433	1.799	1.652	7872	559	141
1390	36.67	36.28	36.41	.0105	.970	.0414	1.957	1.884	7849	1653	142
1680	35.98	35.57	35.71	.0130	.978	.0394	2.094	2.080	7857	2459	143
1860	35.26	34.85	34.99	.0147	.982	.0387	2.189	2.200	7834	2850	144
1900	35.21	34.80	34.94	.0155	.981	.0388	2.203	2.254	7849	3101	145
1015	38.35	37.96	38.09	.0074	.990	.0435	1.744	1.648	8056	536	146
1520	37.18	36.78	36.92	.0114	.983	.0407	2.029	1.925	8001	1970	147
1910	36.53	36.11	36.26	.0145	.980	.0385	2.107	2.151	8001	2945	148
2090	37.17	36.75	36.90	.0156	.974	.0385	2.227	2.241	8079	3342	149
2100	36.41	36.00	36.15	.0160	.971	.0387	2.246	2.264	8071	3353	150
2090	37.14	36.72	36.87	.0156	.975	.0389	2.182	2.243	8079	3377	151
2200	36.04	35.61	35.76	.0170	.978	.0383	2.293	2.315	8009	3594	152
1105	39.58	39.18	39.32	.0078	.990	.0433	1.807	1.659	8246	673	153
1580	38.46	38.04	38.19	.0114	.987	.0406	1.927	1.916	8214	2028	154
2255	37.38	36.96	37.12	.0168	.982	.0380	2.238	2.285	8222	3708	155
2400	37.41	36.98	37.14	.0178	.981	.0384	2.256	2.347	8222	3996	156
495	16.93	16.77	16.83	.0081	.976	.0427	1.859	1.782	7897	979	157
650	16.51	16.34	16.40	.0109	.987	.0402	2.107	2.037	7868	2158	158
800	16.18	16.01	16.07	.0137	.962	.0379	2.170	2.235	7882	3007	159
830	16.14	15.98	16.04	.0148	.957	.0373	2.347	2.307	7868	3201	160
950	15.86	15.70	15.76	.0166	.886	.0378	2.275	2.344	7868	3368	161
545	17.69	17.53	17.59	.0086	1.011	.0423	1.954	1.814	8306	1289	162
800	17.58	17.41	17.48	.0126	.980	.0401	2.148	2.119	8306	2956	163
980	17.29	17.11	17.18	.0157	.951	.0387	2.339	2.309	8306	3831	164
1010	17.11	16.93	17.00	.0164	.961	.0388	2.316	2.365	8298	4028	165
1090	16.95	16.76	16.83	.0179	.947	.0380	2.382	2.455	8298	4347	166
570	18.22	18.08	18.14	.0087	.957	.0375	1.667	1.762	8509	1012	167
785	18.20	18.03	18.10	.0120	.982	.0399	2.062	2.046	8509	2743	168
1030	17.83	17.66	17.73	.0160	.935	.0388	2.305	2.278	8509	3976	169
1080	17.72	17.54	17.61	.0169	.953	.0379	2.328	2.367	8509	4297	170
1150	17.55	17.38	17.45	.0182	.945	.0385	2.439	2.436	8485	4536	171
590	18.31	18.17	18.23	.0090	.982	.0430	2.894	1.794	8735	1088	172
870	18.33	18.17	18.24	.0132	.960	.0400	2.190	2.095	8727	3027	173
1060	18.10	17.93	18.00	.0163	.948	.0383	2.300	2.293	8719	4152	174
1170	17.94	17.76	17.84	.0181	.936	.0376	3.286	2.403	8719	4641	175
1240	17.90	17.72	17.80	.0192	.950	.0374	2.373	2.484	8703	4846	176
290	10.99	10.90	10.94	.0073	1.030	.0445	1.929	1.708	8283	812	177
400	10.77	10.67	10.71	.0103	1.019	.0420	2.132	1.963	8291	1931	178
535	10.61	10.51	10.55	.0140	.975	.0380	2.081	2.194	8253	2878	179
600	10.62	10.51	10.55	.0157	.961	.0397	2.371	2.309	8298	3351	180
400	11.31	11.22	11.26	.0098	1.010	.0423	1.977	1.881	8767	1337	181
550	11.34	11.25	11.29	.0135	.976	.0410	3.708	2.121	8735	2711	182
660	11.24	11.14	11.19	.0163	.943	.0398	2.225	2.281	8727	3812	183
640	11.13	11.02	11.07	.0160	.986	.0394	2.256	2.320	8767	3946	184
750	11.16	11.05	11.10	.0187	.956	.0392	2.459	2.469	8735	4388	185
24-inch diameter tail pipe with 22-inch diameter exhaust nozzle											
1300	36.25	35.86	35.99	.0100	.980	.0415	2.046	1.854	7865	1262	186
1650	35.23	34.82	34.96	.0130	.987	.0396	2.146	2.084	7849	2173	187
1820	34.87	34.46	34.60	.0145	.974	.0392	2.254	2.181	7849	2539	188
1940	34.56	34.15	34.29	.0156	.978	.0392	2.269	2.259	7834	2805	189
1350	37.76	37.37	37.51	.0099	.977	.0378	1.775	1.831	8079	1303	190
1780	36.77	36.37	36.51	.0134	.978	.0401	2.220	2.076	8040	2424	191
1980	36.57	36.15	36.30	.0150	.981	.0390	2.220	2.206	8064	2904	192
2190	36.04	35.61	35.76	.0169	.973	.0388	2.375	2.317	8056	3325	193
2190	37.72	37.30	37.46	.0161	.979	.0387	2.305	2.252	8262	3320	194
2255	36.45	36.04	36.19	.0172	.978	.0381	2.372	2.294	8166	3274	195
2410	36.90	36.47	36.63	.0181	.984	.0383	2.467	2.373	8214	3735	196
630	17.37	17.22	17.28	.0101	1.014	.0419	1.985	1.936	8246	1682	197
865	17.12	16.94	17.01	.0140	.969	.0398	2.281	2.205	8238	2952	198
980	16.94	16.79	16.86	.0160	.961	.0382	2.246	2.339	8246	3521	199

NACA

[redacted]

2253

TABLE I - PERFORMANCE DATA FOR PYTHON

Run	Altitude (ft)	Ram-pressure ratio P_1/P_0	Tunnel static pressure p_0, (lb/sq ft abs.)	Engine speed, N (rpm)	Shaft horsepower shp	Compressor-inlet total pressure, P_1 (lb/sq ft abs.)	Compressor-inlet total temperature, T_1, (°R)	Combustion-chamber-inlet static pressure, p_2 (lb/sq ft abs.)	Combustion-chamber-inlet total pressure, P_2 (lb/sq ft abs.)	Combustion-chamber-inlet total temperature, T_2, (°R)	Combustion-chamber-outlet total pressure, P_3 (lb/sq ft abs.)	Combustion-chamber-outlet total temperature, T_3, (°R)[a]	Exhaust-nozzle-inlet total temperature, T_5, (°R)
24-inch diameter tail pipe with 22-inch diameter exhaust nozzle													
200	30,000	1.026	624	7606	1054	640	442	3306	3359	798	3233	1927	1451
201		1.026	623	7806	506	639	443	3135	3200	796	3069	1567	1165
202		1.026	625	7806	881	641	442	3323	3385	804	3253	1778	1321
203		1.027	623	7806	1037	640	443	3406	3461	810	3328	1880	1404
204		1.027	627	7806	1144	644	444	3467	3525	815	3392	1974	1485
205		1.024	635	8006	284	650	445	3124	3177	831	3041	1475	1072
206		1.024	633	8006	321	648	447	3145	3213	804	3080	1479	1092
207		1.025	629	8006	351	645	446	3141	3210	827	3071	1515	1108
208		1.025	628	8006	484	644	444	3213	3279	809	3142	1555	1149
209		1.024	629	8006	799	644	448	3357	3419	808	3280	1719	1274
210		1.027	629	8006	833	646	444	3397	3460	819	3320	1755	1299
211		1.027	627	8006	995	644	445	3504	3568	825	3427	1885	1406
212		1.025	631	8006	1042	647	444	3544	3603	827	3462	1914	1427
213		1.025	629	8006	1053	645	440	3524	3581	797	3441	1882	1415
214		1.025	632	8006	1086	648	446	3587	3641	818	3502	1928	1446
215		1.027	624	8006	1133	641	441	3664	3718	829	3578	2054	1557
216		1.025	630	8006	1207	646	445	[illegible]	3717	806	3576	2017	1536
217		1.025	631	8006	1291	647	448	3629	3683	839	3541	2100	1579
218	40,000	1.026	389	7606	253	399	439	1847	1884	785	1803	1504	1104
219		1.025	394	7606	459	404	440	1985	2021	790	1941	1732	1300
220		1.026	390	7606	465	400	444	1971	2007	825	1929	1740	1274
221		1.023	399	7606	593	408	440	2058	2091	792	2009	1857	1396
222		1.025	398	7606	671	408	438	2106	2138	779	2057	1916	1453
223		1.028	394	8006	496	405	442	2126	2165	824	2077	1782	1318
224		1.025	393	8006	589	403	443	2174	2204	828	2115	1871	1389
225		1.025	395	8006	654	405	443	2199	2238	830	2146	1935	1442
226		1.028	391	8006	764	402	442	2260	2294	833	2204	2058	1536
24-inch diameter tail pipe with 20-inch diameter exhaust nozzle													
227	10,000	1.026	1448	7606	748	1485	487	6254	6393	817	6127	1507	1139
228		1.026	1449	7606	1377	1486	486	6603	6732	825	6464	1695	1292
229		1.026	1449	7606	1603	1486	486	6681	6803	828	6536	1882	1360
230		1.025	1450	7606	1727	1486	489	6744	6869	835	6600	1840	1409
231		1.026	1448	7806	847	1485	486	6612	6757	834	6478	1540	1157
232		1.026	1450	7806	1585	1487	487	7012	7147	845	6864	1772	1341
233		1.026	1447	7806	1618	1485	483	7050	7184	841	6900	1755	1329
234		1.025	1451	7806	1889	1487	490	7120	7250	852	6961	1885	1429
235		1.025	1451	7806	2033	1488	488	7207	7333	854	7047	1932	1464
236		1.026	1450	8006	909	1487	483	6910	7063	844	6770	1570	1173
237		1.025	1455	8006	1801	1492	488	7358	7495	862	7200	1841	1389
238		1.026	1450	8006	2079	1487	492	7461	7597	871	7301	1956	1478
239	30,000	1.025	632	7606	369	648	441	3022	3089	777	2973	1500	1133
240		1.027	629	7606	504	646	445	3055	3116	784	2991	1573	1178
241		1.027	629	7606	748	646	444	3190	3247	790	3120	1746	1307
242		1.024	632	7606	803	647	439	3244	3302	787	3177	1757	1319
243		1.025	628	7606	913	644	442	3267	3324	794	3207	1858	1399
244		1.025	630	7606	935	646	442	3294	3351	794	3228	1857	1404
245		1.025	629	7606	1011	645	443	3303	3362	799	3229	1943	1469
246		1.025	629	7806	390	645	444	3097	3165	796	3040	1528	1149
247		1.026	627	7806	483	643	439	3165	3224	793	3098	1559	1166
248		1.026	626	7806	835	642	442	3331	3390	807	3260	1794	1338
249		1.025	632	7806	847	648	443	3381	3443	805	3309	1781	1333
250		1.027	624	7806	982	641	438	3426	3485	806	3352	1869	1397
251		1.025	628	7806	1026	644	445	3445	3502	813	3372	1927	1449
252		1.025	629	7806	1094	645	441	3482	3538	815	3400	1969	1482
253		1.025	630	8006	351	646	445	3182	3251	810	3119	1546	1160
254		1.026	626	8006	519	642	445	3264	3331	816	3196	1637	1220
255		1.025	632	8006	903	648	445	3493	3555	821	3421	1844	1379
256		1.026	635	8006	903	641	441	3468	3531	825	3390	1860	1383
257		1.025	628	8006	1110	644	444	3595	3654	832	3514	1989	1492
258		1.027	626	8006	1201	643	444	3645	3700	834	3574	2054	1545
259	40,000	1.030	396	7606	437	408	436	2017	2053	790	1970	1736	1303
260		1.028	395	7606	482	406	436	2031	2068	795	1985	1815	1366
261		1.026	392	7606	560	402	439	2043	2078	800	1996	1917	1453
262		1.028	393	7606	615	404	440	2086	2119	801	2036	1966	1493
263		1.028	391	8006	412	402	436	2097	2127	817	2039	1727	1276
264		1.031	389	8006	554	401	438	2150	2193	824	2103	1857	1381
265		1.026	391	8006	683	401	437	2247	2287	832	2198	2027	1522
266		1.028	392	8006	753	403	438	2303	2336	832	2250	2092	1587

[a]Calculated temperature.

[b]Determined from air flow calculated at station 3.

[c]Corrected to NACA standard sea-level static conditions.

[redacted]

TURBINE-PROPELLER ENGINE - Concluded

Fuel flow, $W_f \times 3600$ (lb/hr)	Engine-inlet air flow $W_{a,1}$, (lb/sec)[b]	Combustion-chamber air flow, $W_{a,3}$, (lb/sec)	Exhaust-nozzle-inlet air flow, $W_{a,5}$, (lb/sec)[b]	Fuel-air ratio (W_f/W_a), f/a	Combustion efficiency, η_b	Combustion-chamber total-pressure-loss ratio, $\Delta P/P$	Ratio of combustion-chamber total-pressure loss to inlet impact pressure, $\Delta P/q$	Combustion-chamber temperature ratio T_3/T_2	Corrected engine speed, $N/\sqrt{\theta_1}$, (rpm)[a]	Corrected shaft horsepower shp/$\delta_1\sqrt{\theta_1}$[a]	Run
24-inch diameter tail pipe with 22-inch diameter exhaust nozzle											
1015	16.67	16.49	16.56	.0169	.974	.0375	2.377	2.415	8238	3778	200
700	17.71	17.55	17.62	.0110	.988	.0409	2.015	1.969	8446	1813	201
900	17.52	17.35	17.42	.0143	.982	.0390	2.129	2.211	8462	3152	202
1000	17.38	17.21	17.28	.0160	.975	.0384	2.418	2.321	8446	3709	203
1090	17.24	17.07	17.14	.0176	.971	.0377	2.293	2.422	8438	4063	204
595	18.13	17.98	18.04	.0091	.991	.0428	2.566	1.775	8646	998	205
625	18.35	18.19	18.26	.0095	.992	.0414	1.956	1.840	8622	1129	206
625	18.07	17.91	17.98	.0096	1.008	.0433	2.014	1.832	8638	1243	207
695	18.20	18.05	18.12	.0106	.994	.0418	2.076	1.922	8654	1719	208
875	17.99	17.82	17.89	.0135	.962	.0407	2.242	2.127	8614	2825	209
890	18.00	17.84	17.91	.0137	.980	.0405	2.222	2.143	8654	2950	210
1030	17.85	17.68	17.75	.0160	.963	.0395	2.203	2.285	8646	3531	211
1050	17.91	17.74	17.81	.0163	.975	.0391	2.390	2.314	8654	3683	212
1050	17.95	17.78	17.85	.0163	.971	.0391	2.456	2.361	8695	3752	213
1115	18.02	17.85	17.92	.0172	.946	.0382	2.574	2.357	8638	3826	214
1225	17.79	17.61	17.69	.0191	.948	.0377	2.593	2.478	8687	4058	215
1215	17.95	17.76	17.84	.0188	.950	.0379	2.712	2.502	8646	4270	216
1225	17.40	17.22	17.30	.0196	.960	.0386	2.630	2.503	8614	4543	217
360	10.65	10.56	10.60	.0094	1.053	.0430	2.189	1.892	8268	1458	218
500	10.61	10.51	10.55	.0131	1.030	.0396	2.222	2.192	8260	2611	219
490	10.53	10.42	10.46	.0129	1.010	.0390	2.167	2.109	8222	2659	220
600	10.55	10.45	10.49	.0158	.973	.0392	2.485	2.345	8260	3340	221
660	10.63	10.52	10.56	.0172	.961	.0379	2.531	2.460	8283	3790	222
575	11.16	11.07	11.11	.0143	.963	.0407	2.256	2.163	8679	2809	223
630	11.06	10.96	11.01	.0158	.958	.0404	2.967	2.260	8670	3350	224
665	11.03	10.93	10.98	.0167	.968	.0411	2.359	2.331	8670	3701	225
750	10.94	10.83	10.88	.0190	.952	.0392	2.647	2.471	8679	4359	226
24-inch diameter tail pipe with 20-inch diameter exhaust nozzle											
1280	36.20	35.80	35.93	.0098	.982	.0416	1.914	1.845	7849	1100	227
1655	35.81	35.40	35.54	.0128	.972	.0398	2.078	2.055	7857	2026	228
1790	34.25	33.84	33.98	.0145	.953	.0392	2.189	2.273	7857	2358	229
1890	34.96	34.55	34.69	.0150	.974	.0392	2.152	2.204	7834	2534	230
1390	37.62	37.42	37.56	.0102	.974	.0413	1.924	1.847	8064	1247	231
1820	37.11	36.69	36.84	.0136	.983	.0396	2.096	2.097	8056	2328	232
1820	37.50	37.08	37.23	.0135	.982	.0395	2.119	2.087	8095	2391	233
2010	35.38	35.96	36.11	.0153	.981	.0399	2.223	2.212	8032	2735	234
2120	36.36	35.93	36.08	.0162	.972	.0390	2.270	2.262	8056	2986	235
1460	39.11	38.72	38.86	.0104	.989	.0415	1.915	1.860	8302	1342	236
1990	38.10	37.69	37.84	.0145	.982	.0394	2.153	2.136	8232	2635	237
2180	37.40	36.98	37.14	.0162	.982	.0390	2.176	2.246	8222	3037	238
680	17.52	17.39	17.45	.0108	.943	.0376	1.731	1.931	8253	1307	239
690	17.23	17.07	17.13	.0111	.996	.0401	2.049	2.006	8214	1783	240
850	16.98	16.80	16.87	.0139	.973	.0391	2.229	2.210	8222	2649	241
880	17.20	17.05	17.12	.0142	.977	.0379	2.155	2.233	8268	2854	242
955	16.86	16.68	16.75	.0157	.976	.0352	2.053	2.340	8245	3252	243
970	16.95	16.80	16.87	.0159	.974	.0373	2.193	2.339	8245	3320	244
1025	16.57	16.39	16.46	.0172	.967	.0396	2.254	2.432	8237	3592	245
665	17.77	17.63	17.70	.0104	.997	.0395	1.838	1.920	8438	1383	246
710	17.92	17.76	17.83	.0110	.985	.0391	2.136	1.966	8485	1728	247
910	17.47	17.30	17.37	.0145	.981	.0384	2.203	2.223	8462	2983	248
925	17.78	17.63	17.70	.0144	.972	.0389	2.161	2.212	8446	2992	249
1000	17.56	17.39	17.46	.0158	.972	.0382	2.254	2.319	8501	3530	250
1050	17.35	17.20	17.27	.0168	.968	.0371	2.281	2.370	8430	3641	251
1090	17.31	17.14	17.21	.0175	.968	.0390	2.464	2.416	8470	3895	252
685	18.11	17.97	18.04	.0105	.992	.0406	1.913	1.909	8646	1242	253
735	18.00	17.85	17.92	.0118	.987	.0405	2.015	2.006	8646	1848	254
985	18.05	17.90	17.97	.0152	.977	.0377	2.161	2.249	8646	3184	255
985	17.80	17.64	17.71	.0154	.973	.0399	2.238	2.255	8687	3235	256
1130	17.78	17.61	17.68	.0177	.964	.0383	2.373	2.391	8654	3943	257
1200	17.78	17.60	17.68	.0187	.963	.0341	2.291	2.463	8654	4273	258
530	10.74	10.64	10.68	.0137	.985	.0404	2.309	2.197	8298	2473	259
530	10.56	10.48	10.50	.0147	.992	.0401	2.243	2.283	8298	2741	260
610	10.31	10.21	10.25	.0164	.987	.0395	2.343	2.396	8268	3204	261
650	10.38	10.27	10.31	.0174	.977	.0392	2.515	2.454	8260	3498	262
520	11.14	11.06	11.10	.0130	1.001	.0414	2.933	2.114	8735	2366	263
605	11.04	10.95	10.99	.0152	.983	.0410	2.093	2.254	8719	3184	264
720	11.02	10.91	10.96	.0181	.971	.0389	2.225	2.436	8727	3929	265
785	11.08	10.96	11.01	.0197	.956	.0368	2.606	2.514	8719	4305	266

NACA

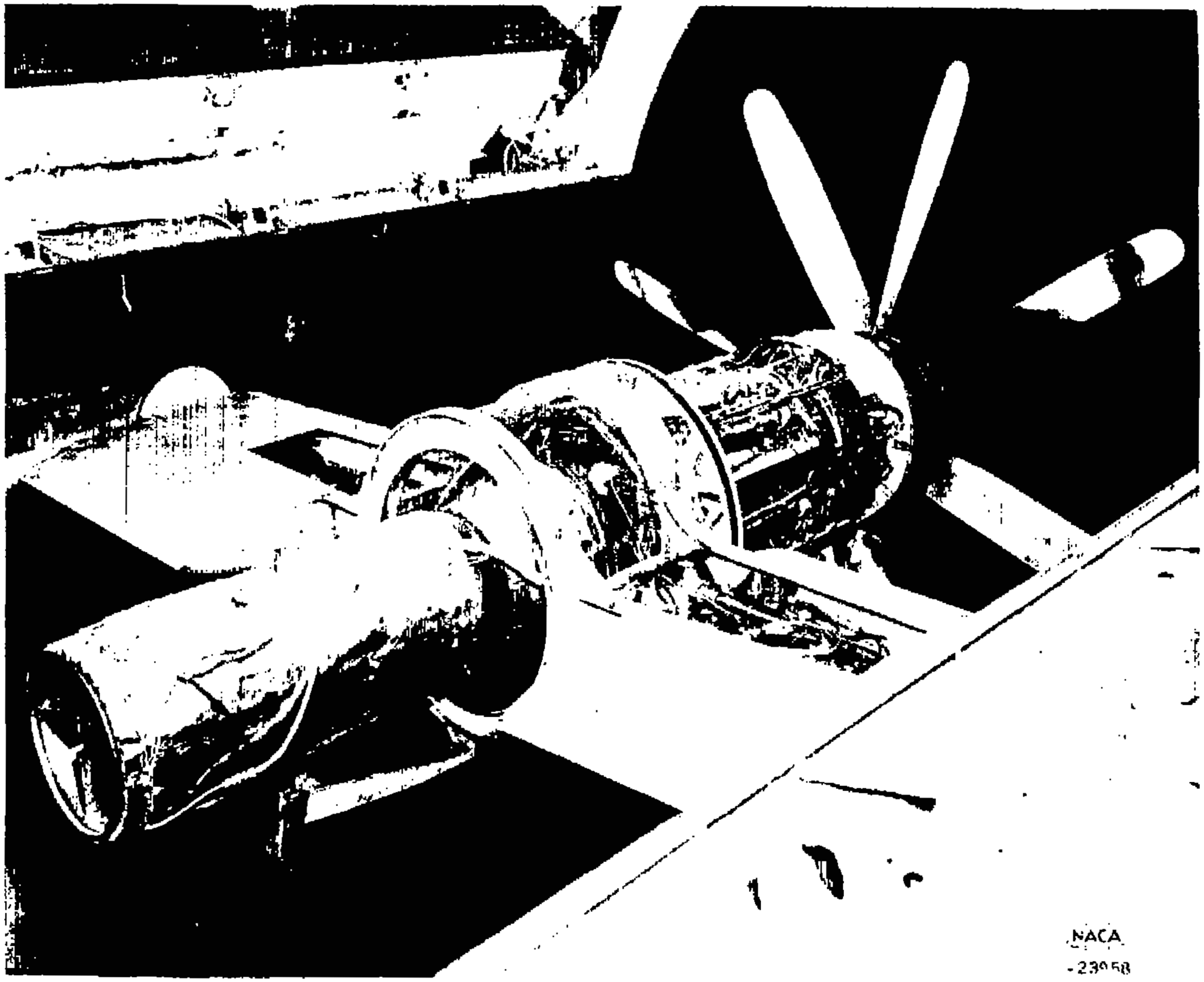


Figure 1. - Installation of Python turbine-propeller engine in altitude wind tunnel.

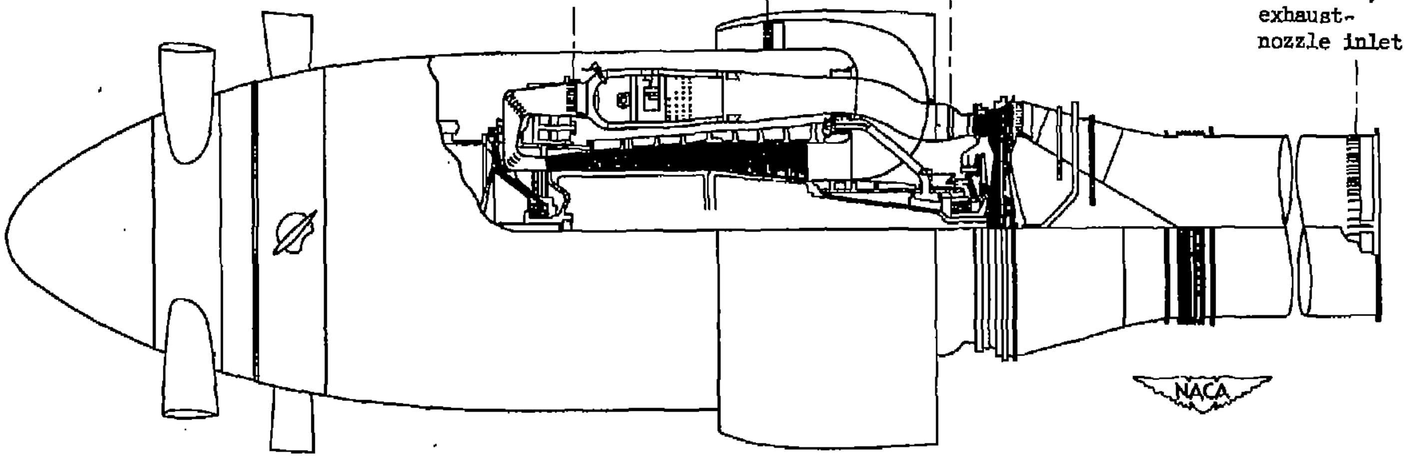


Figure 2. - Cross section of Python turbine-propeller engine showing instrumentation stations.

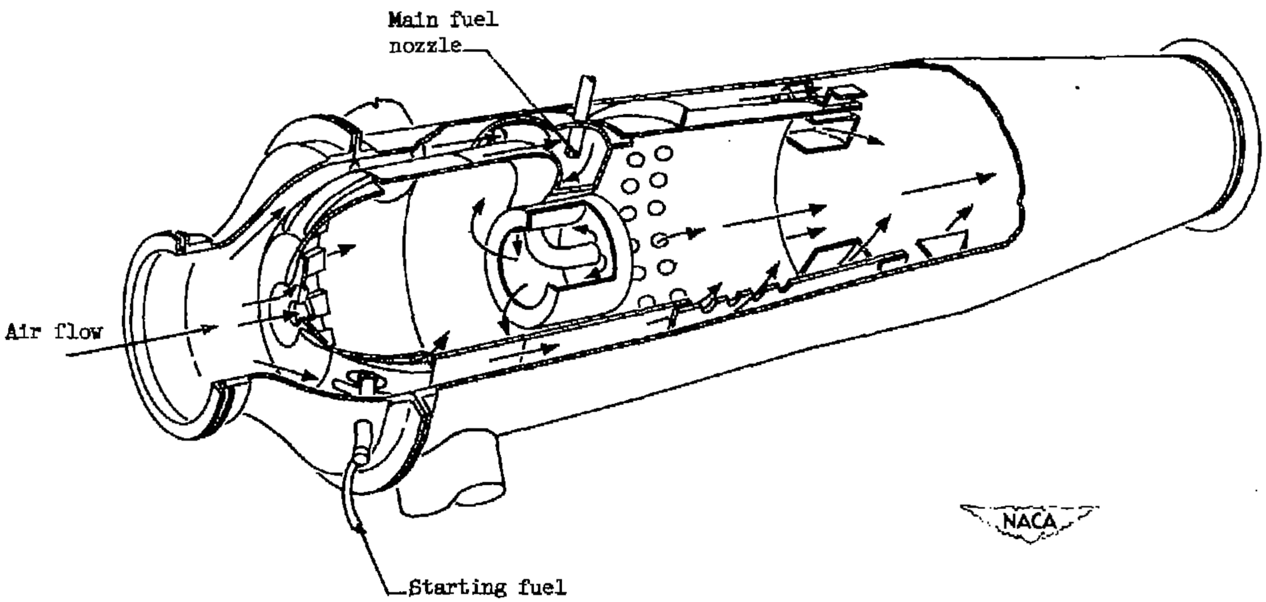
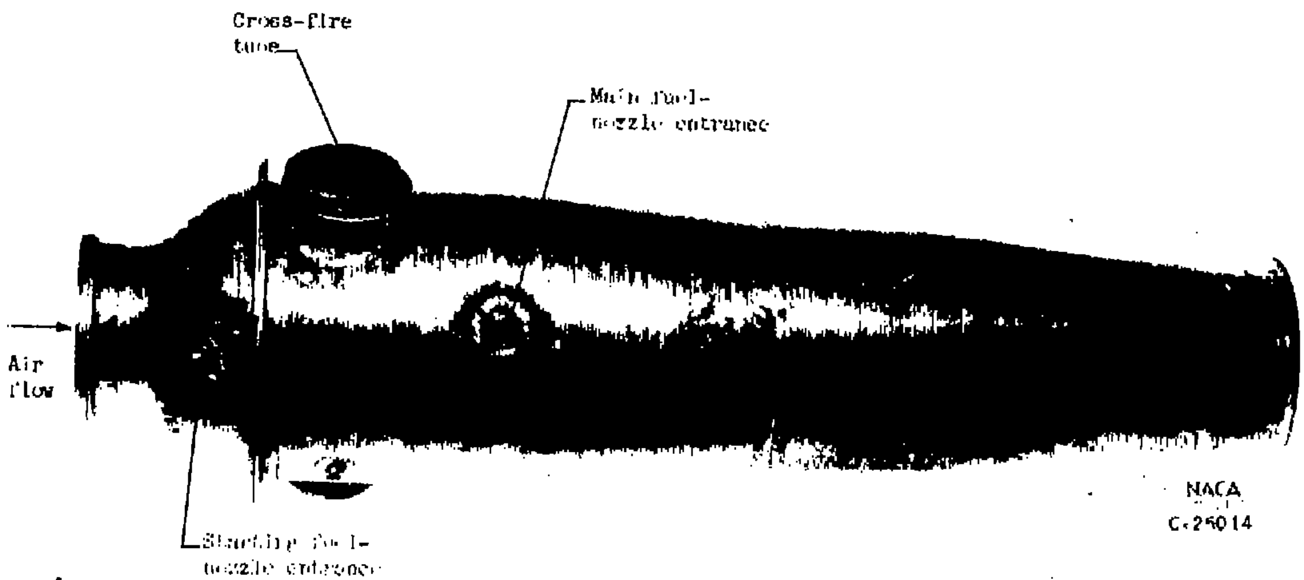
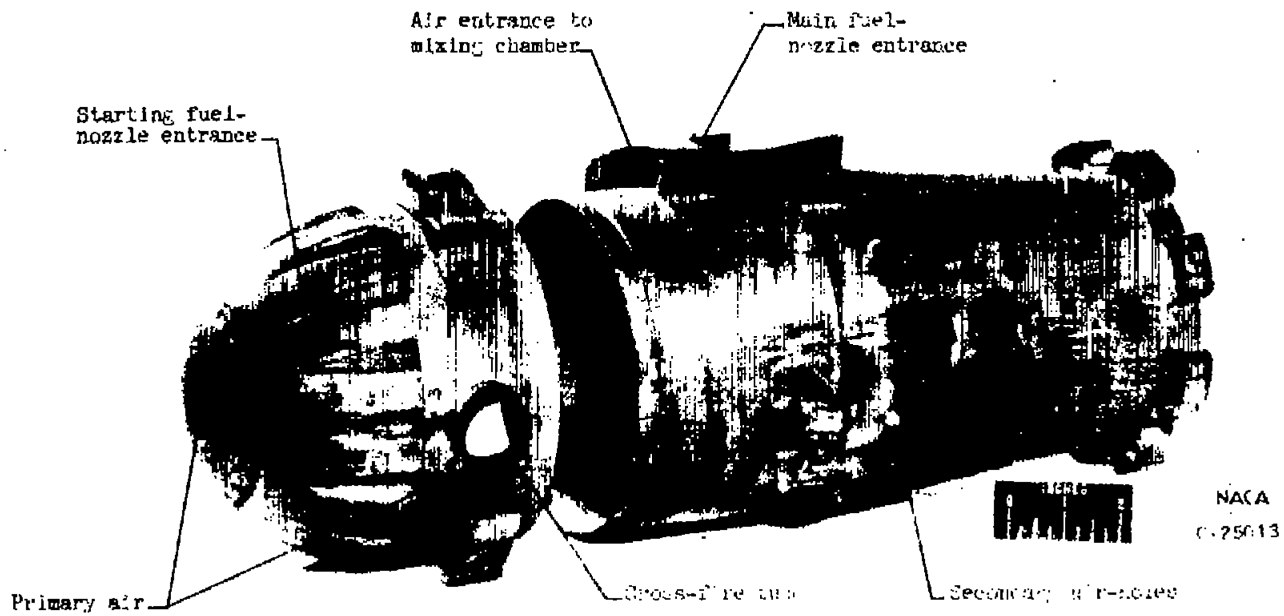


Figure 3. - Cut-away sketch of combustion chamber.



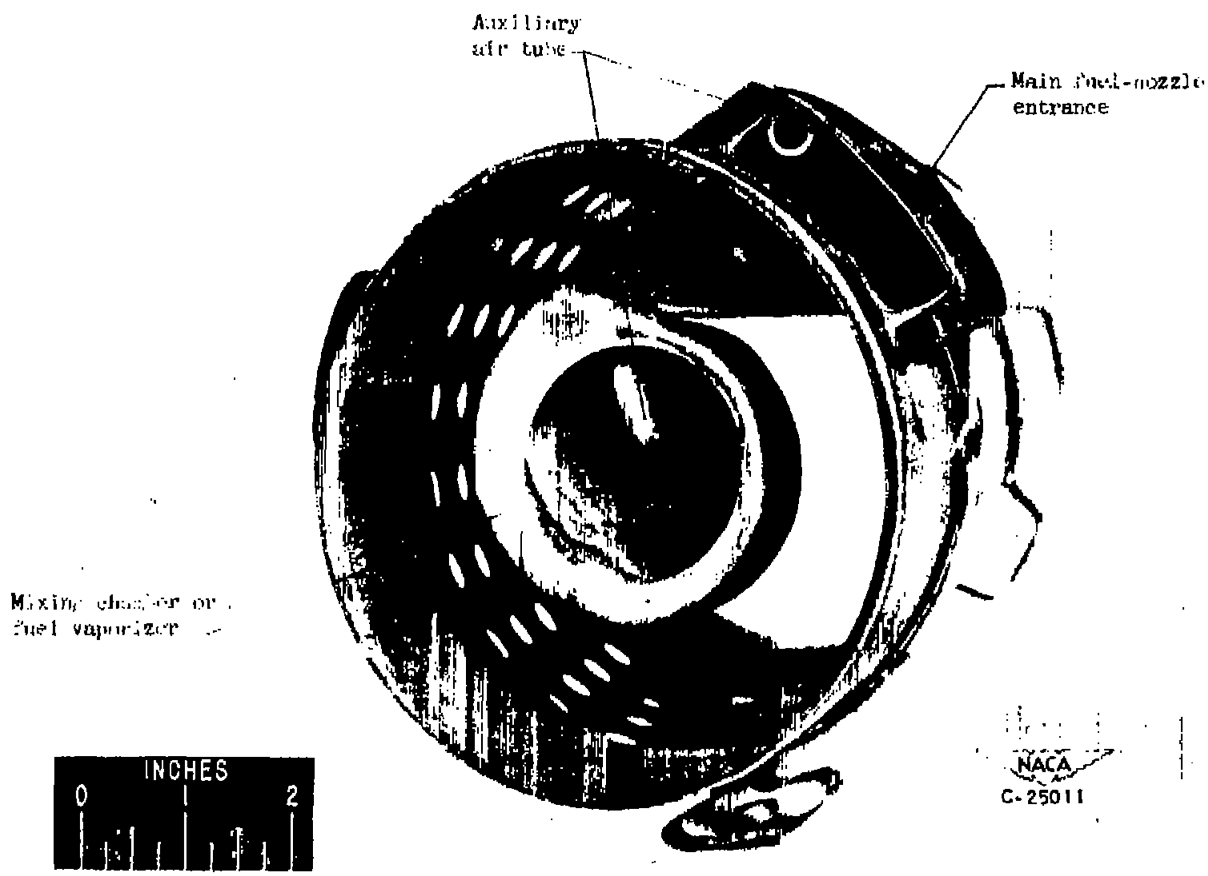
(a) Side view of combustion-chamber outer shell.

Figure 4. - Combustion chamber.



(b) Side view of combustion-chamber liner and liner dome.

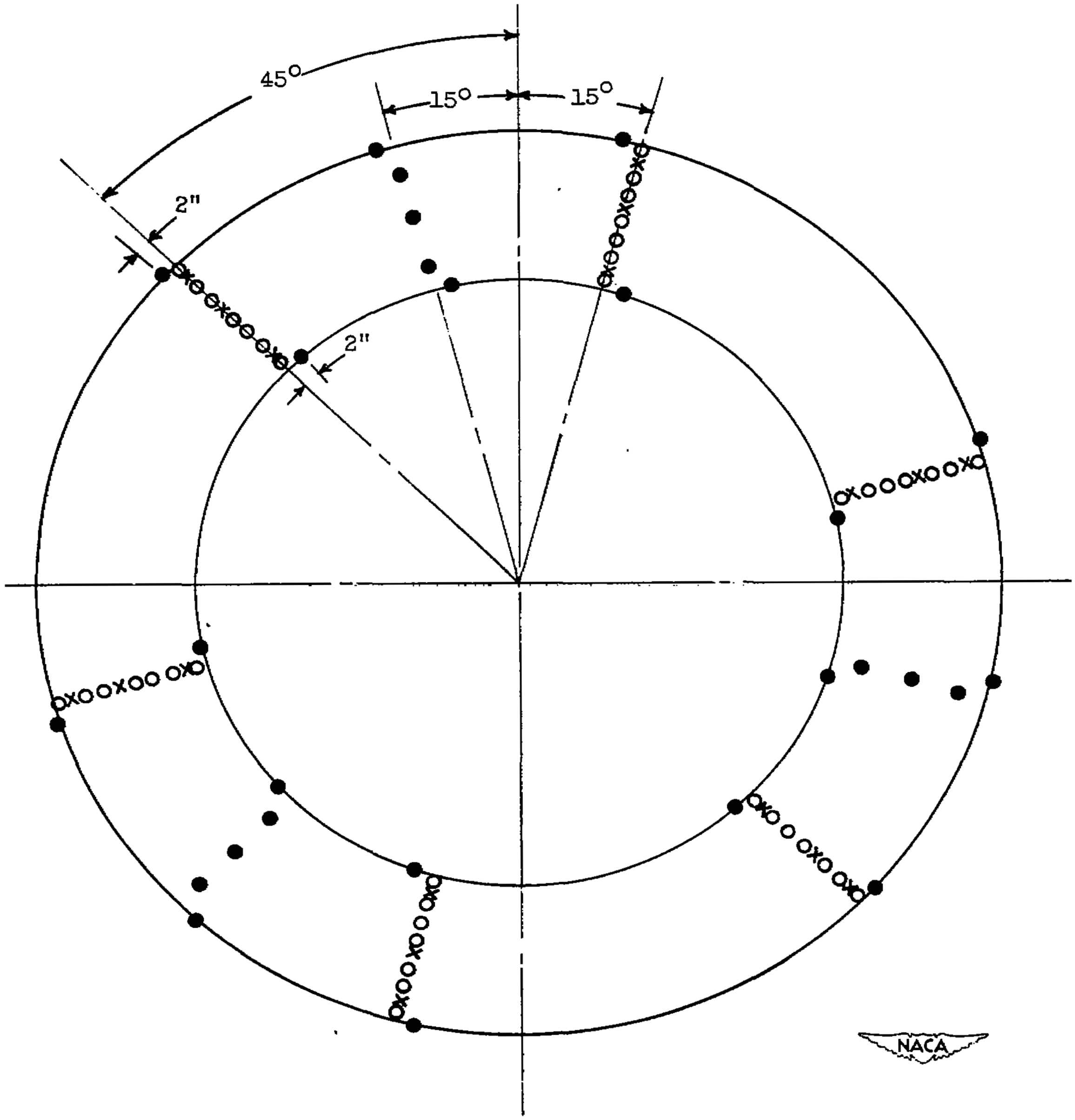
Figure 4. - Continued. Combustion chamber.



(c) Front view of combustion chamber liner showing fuel vaporizer.

Figure 4. - Concluded. Combustion chamber.

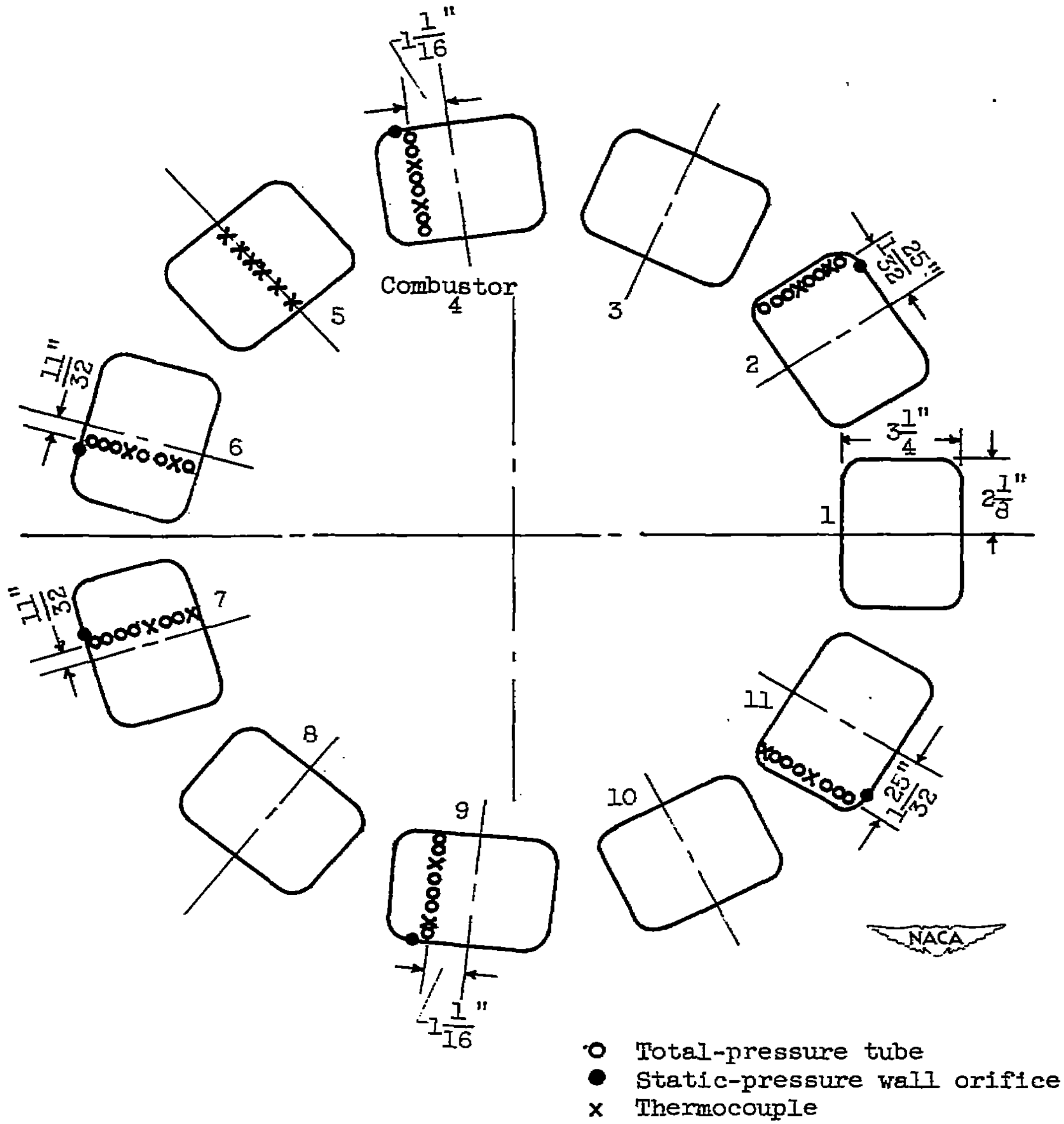
2253



o Total-pressure tube
● Static-pressure tube or wall orifice
x Thermocouple

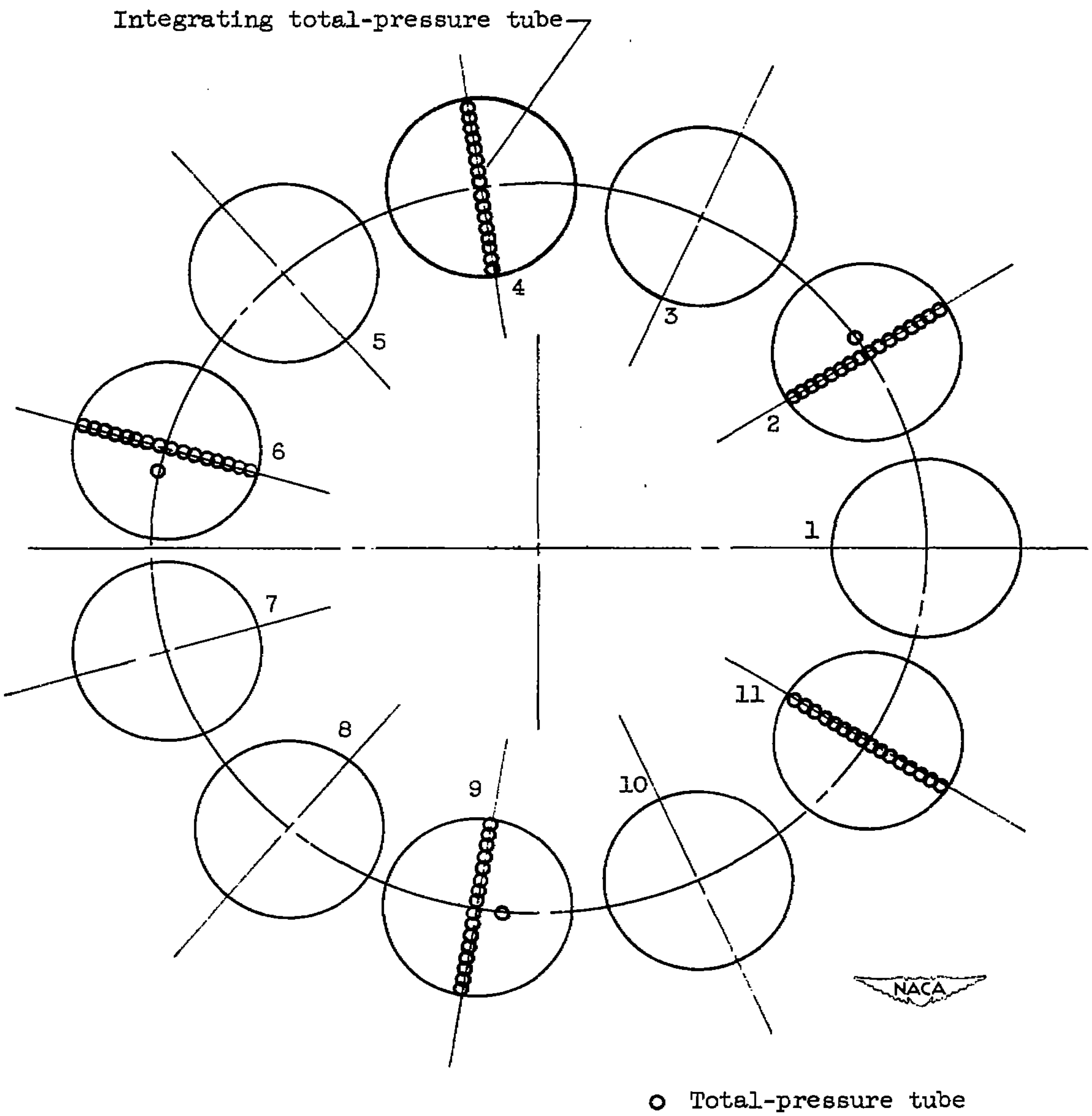
(a) Cowl inlet, station 1, 8 inches downstream of tip of cowling. Downstream view.

Figure 5. - Location of instrumentation.



(b) Combustion-chamber inlet, station 2, $3\frac{1}{4}$ inches upstream of combustion-chamber-inlet flange. Downstream view.

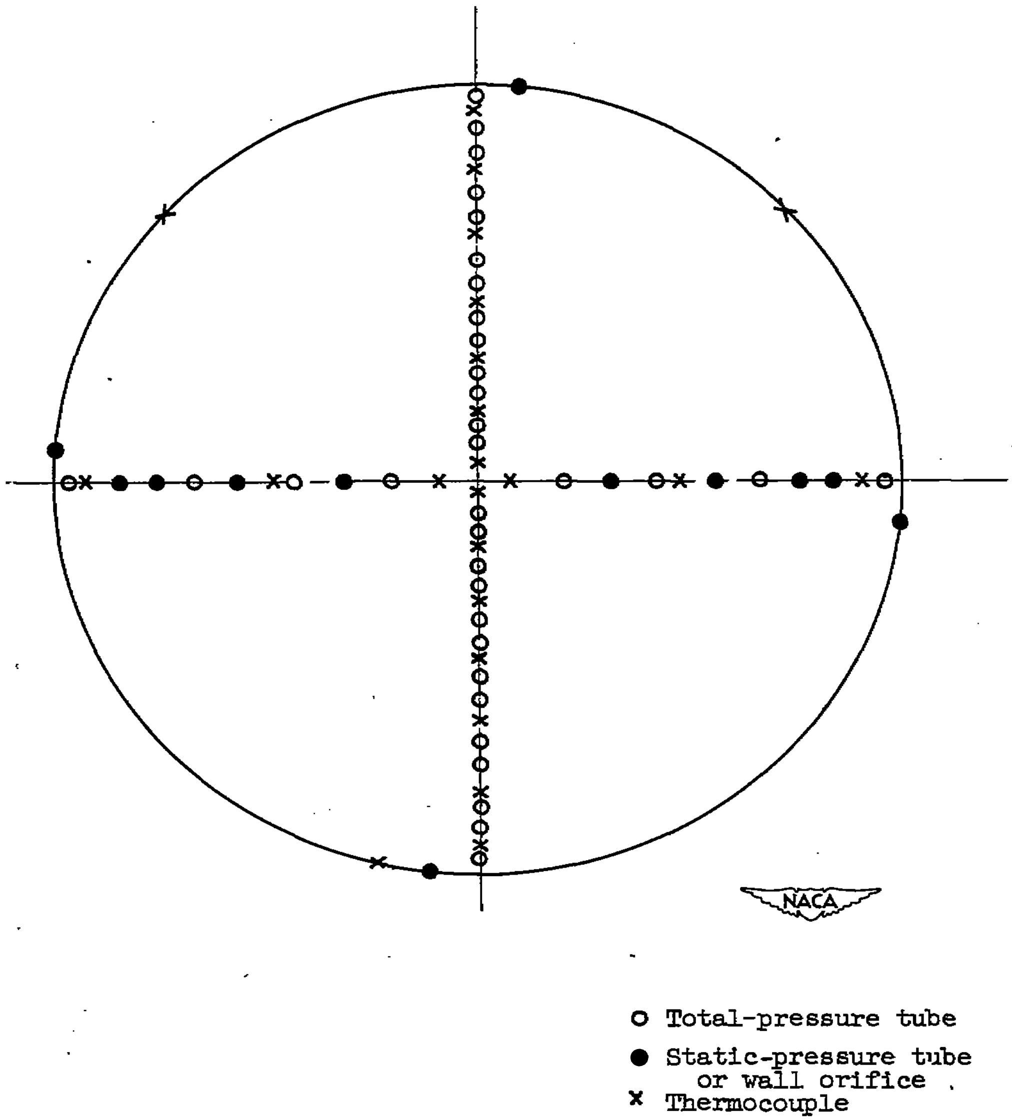
Figure 5. - Continued. Location of instrumentation.



(c) Turbine inlet, station 3, 3 inches upstream of turbine flange.
Downstream view.

Figure 5. - Continued. Location of instrumentation.

2250



(d) Exhaust-nozzle inlet, station 5, $5\frac{1}{4}$ inches upstream of nozzle-inlet flange.

Figure 5. - Concluded. Location of instrumentation.

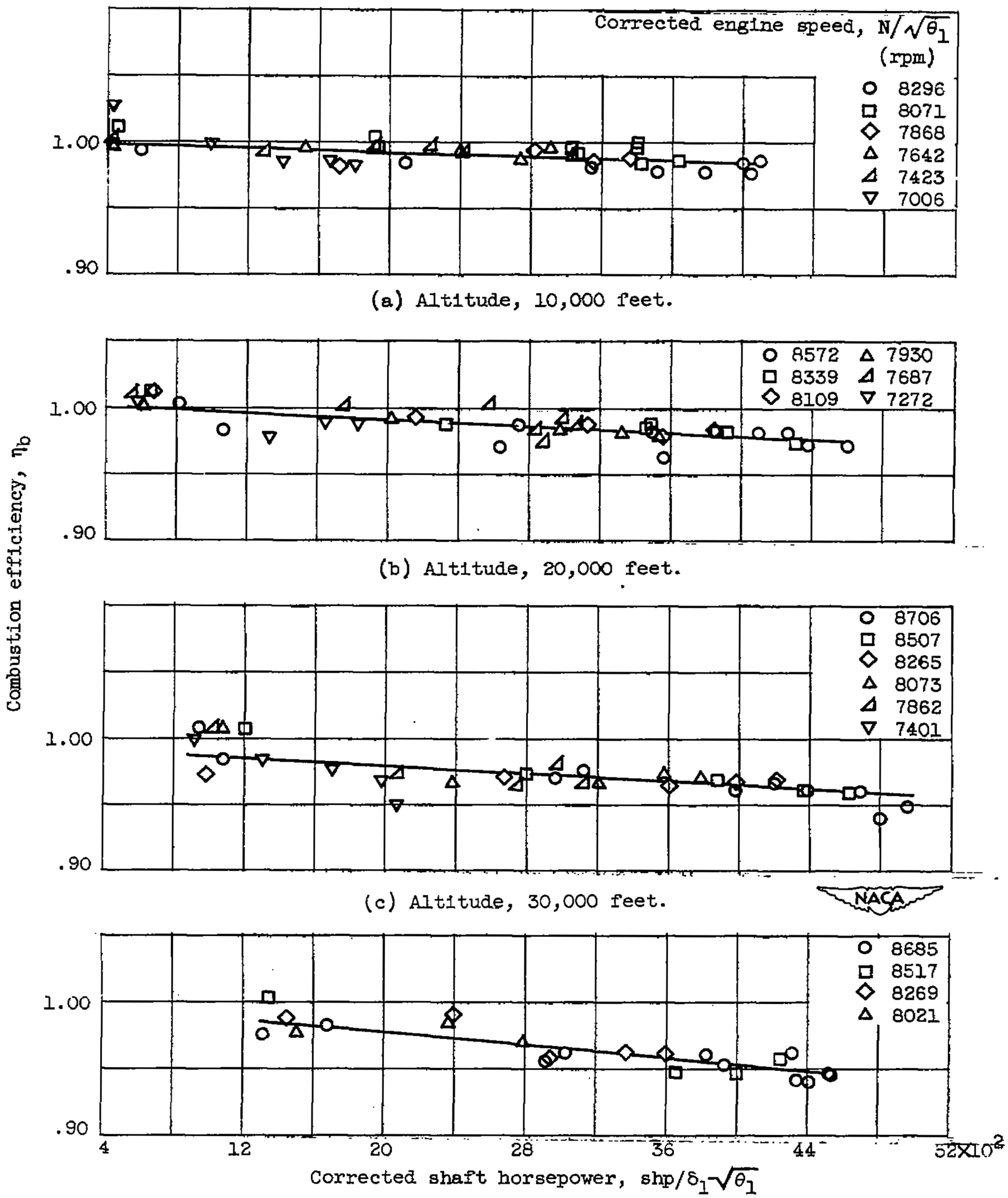
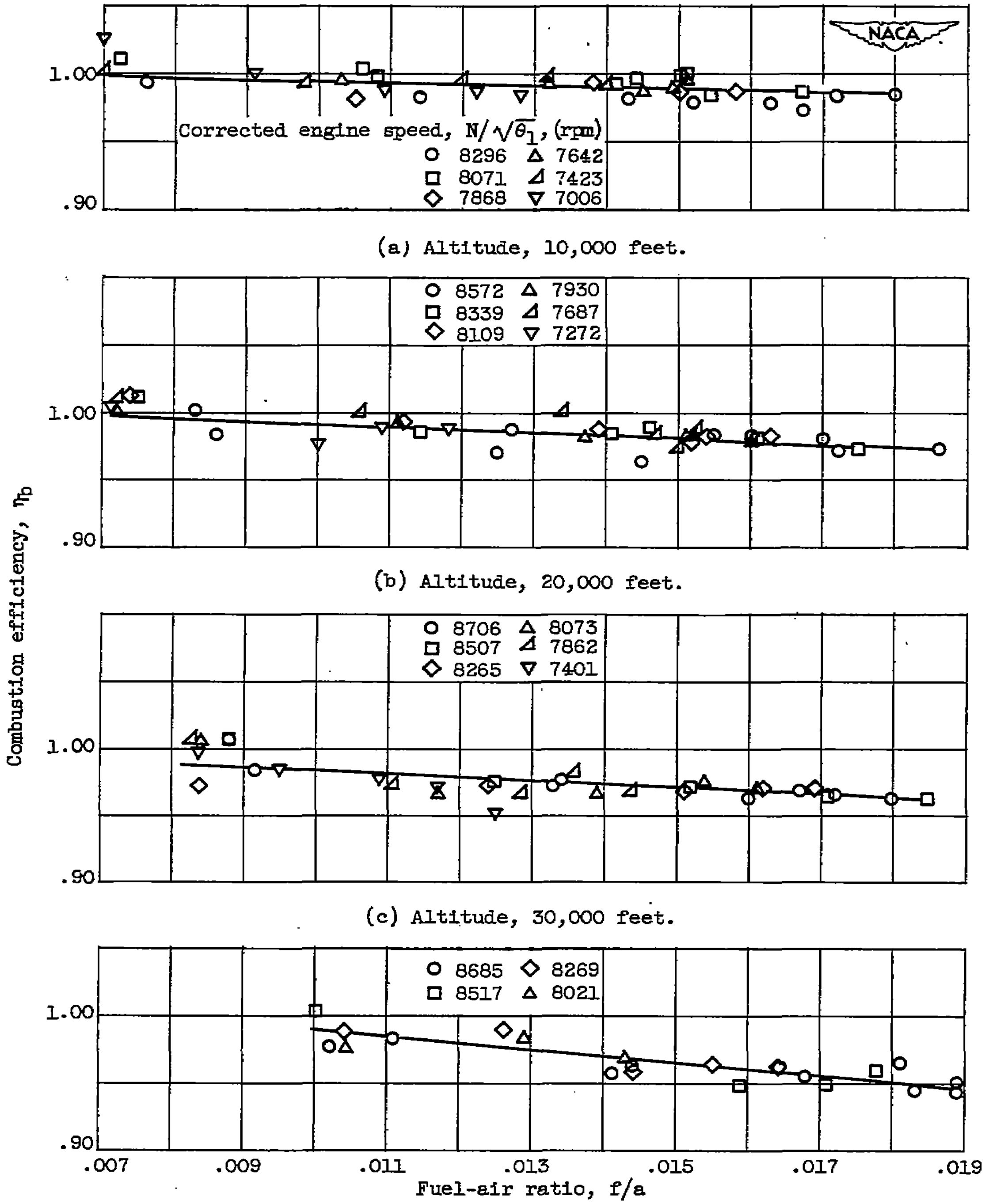


Figure 6. - Effect of corrected shaft horsepower and engine speed on combustion efficiency of engine with standard tail pipe at simulated altitudes of 10,000, 20,000, 30,000, and 40,000 feet.



(a) Altitude, 10,000 feet.

(b) Altitude, 20,000 feet.

(c) Altitude, 30,000 feet.

(d) Altitude, 40,000 feet.

Figure 7. - Effect of fuel-air ratio and engine speed on combustion efficiency of engine with standard tail pipe at simulated altitudes of 10,000, 20,000, 30,000, and 40,000 feet.

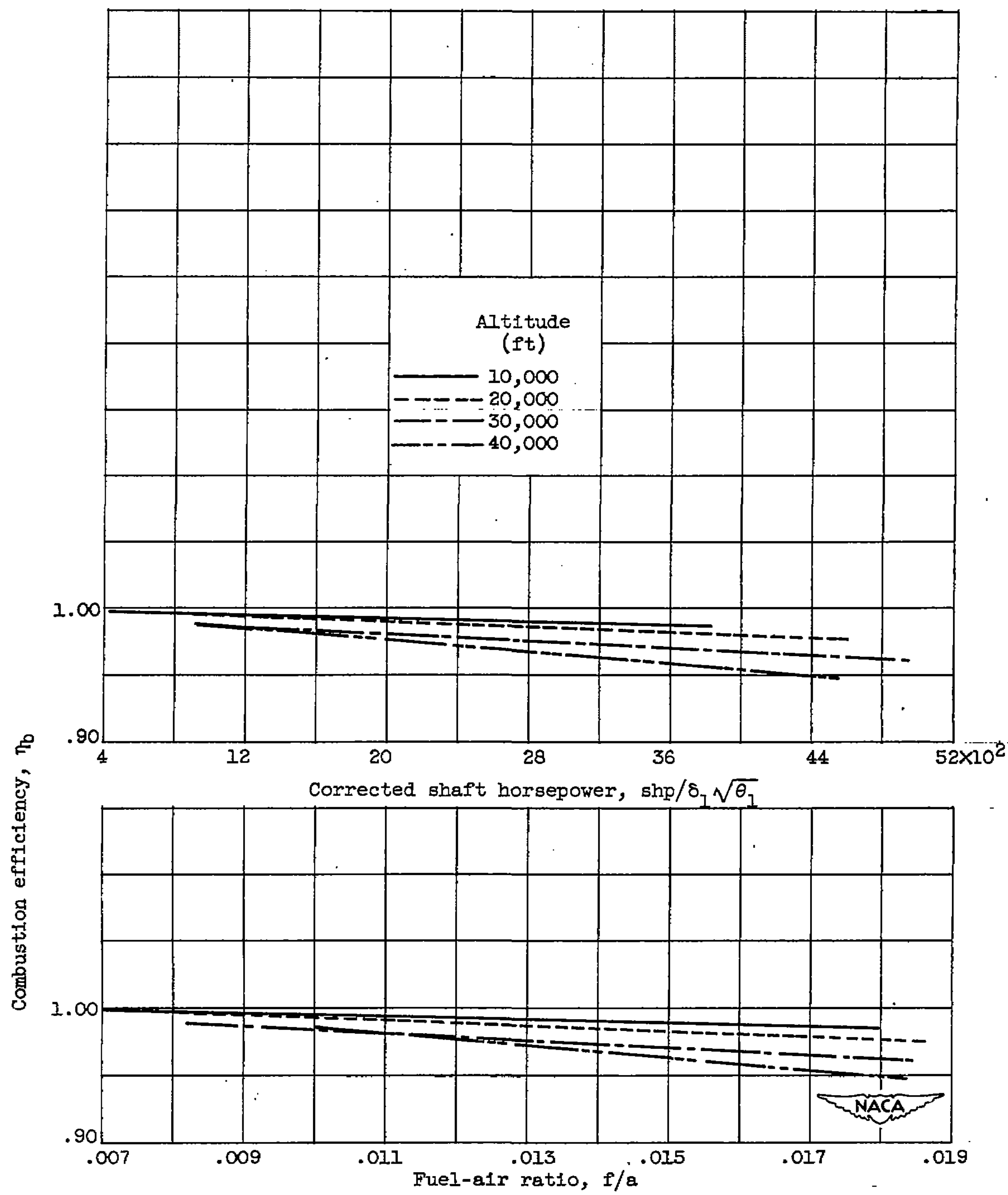
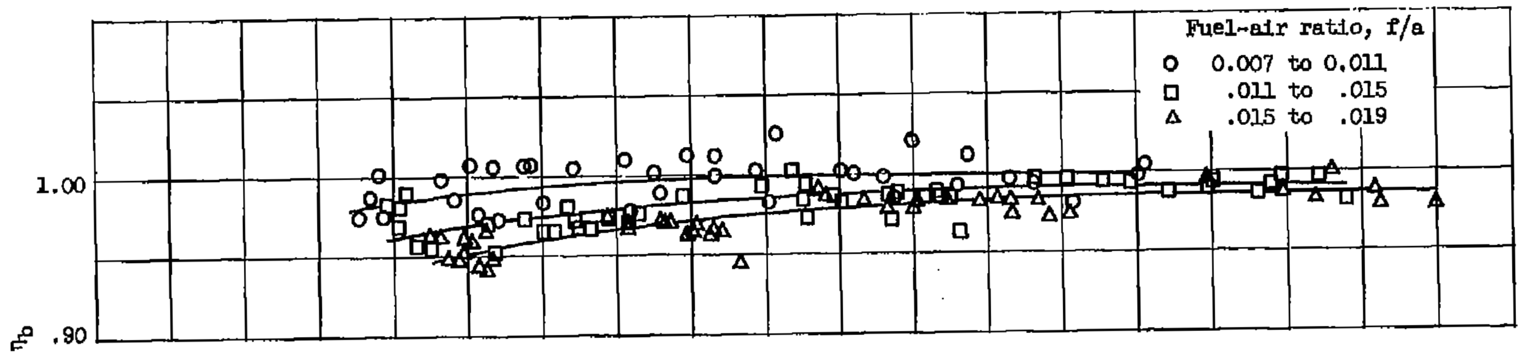
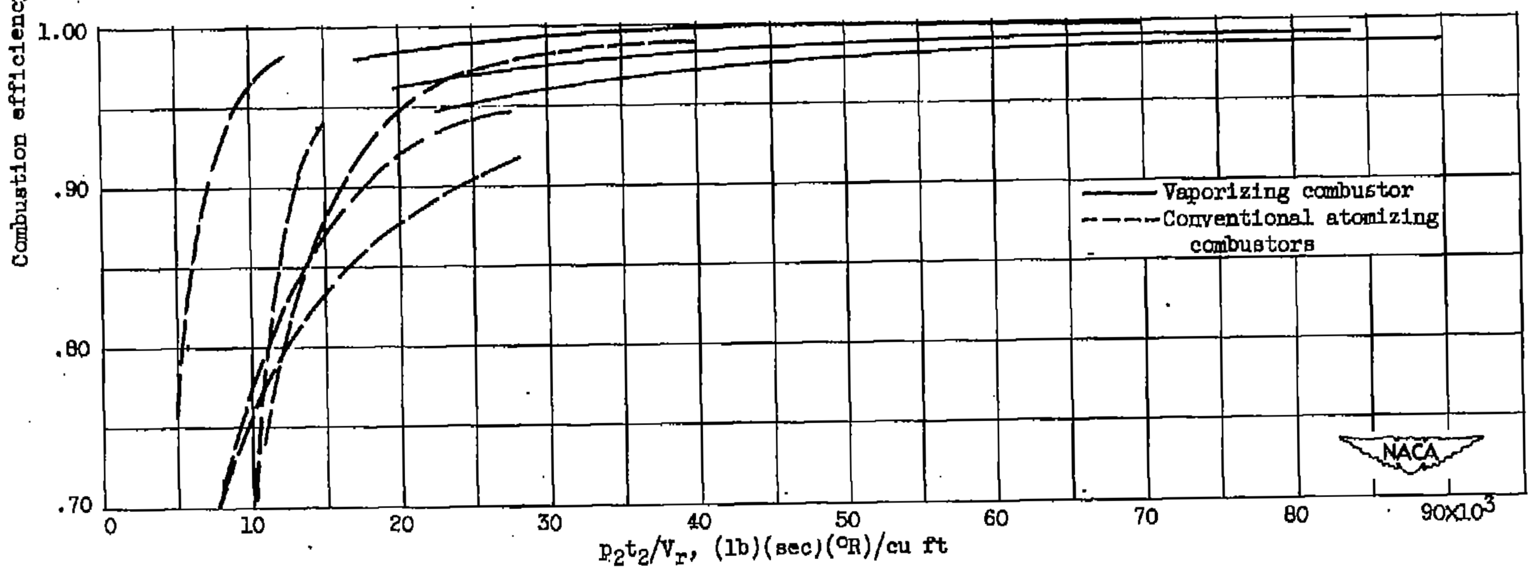


Figure 8. - Effect of corrected shaft horsepower, fuel-air ratio, and altitude on combustion efficiency of engine with standard tail pipe.

[redacted]



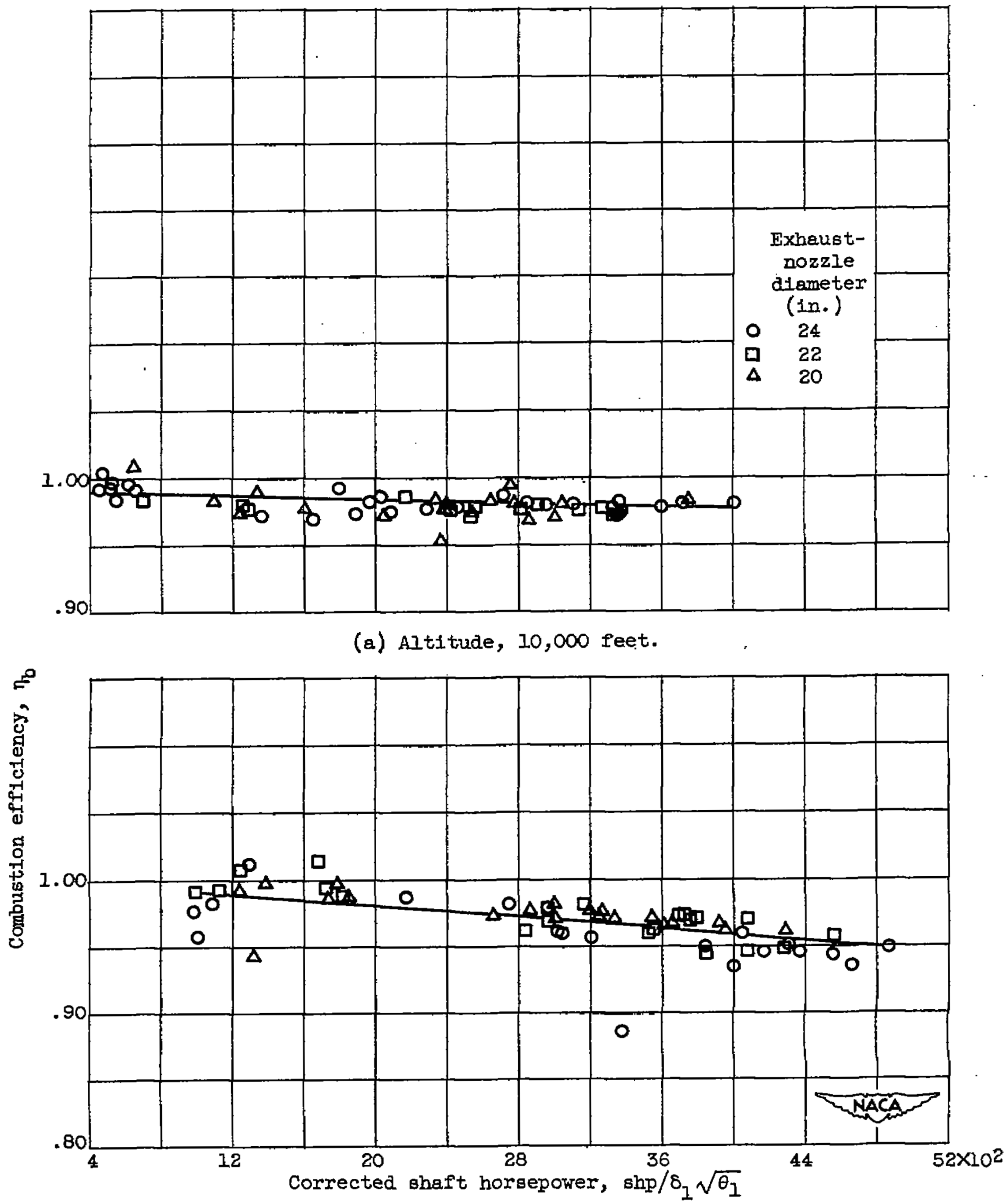
(a) Vaporizing combustor.



(b) Comparison of vaporizing combustor with conventional atomizing combustors.

Figure 9. - Variation of combustion efficiency with p_2t_2/V_r for vaporizing combustor on turbine-propeller engine and for several atomizing combustors used on turbojet engines.

[redacted]



(a) Altitude, 10,000 feet.

(b) Altitude, 30,000 feet.

Figure 10. - Effect of corrected shaft horsepower and exhaust-nozzle diameter on combustion efficiency of engine with 24-inch-diameter tail pipe at simulated altitudes of 10,000 and 30,000 feet.

[redacted]

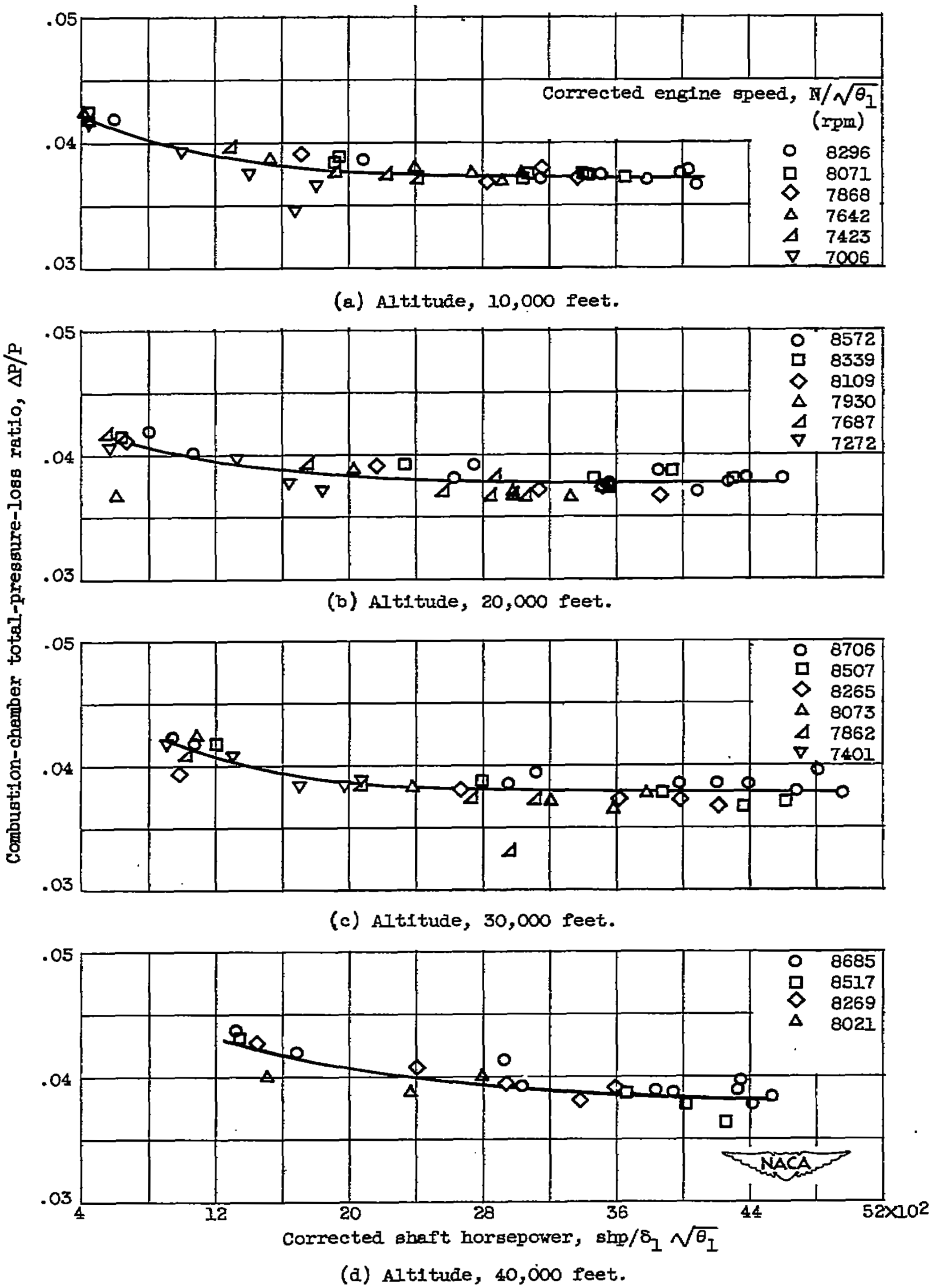


Figure 11. - Effect of corrected shaft horsepower and engine speed on combustion-chamber total-pressure-loss ratio of engine with standard tail pipe at simulated altitudes of 10,000, 20,000, 30,000, and 40,000 feet.

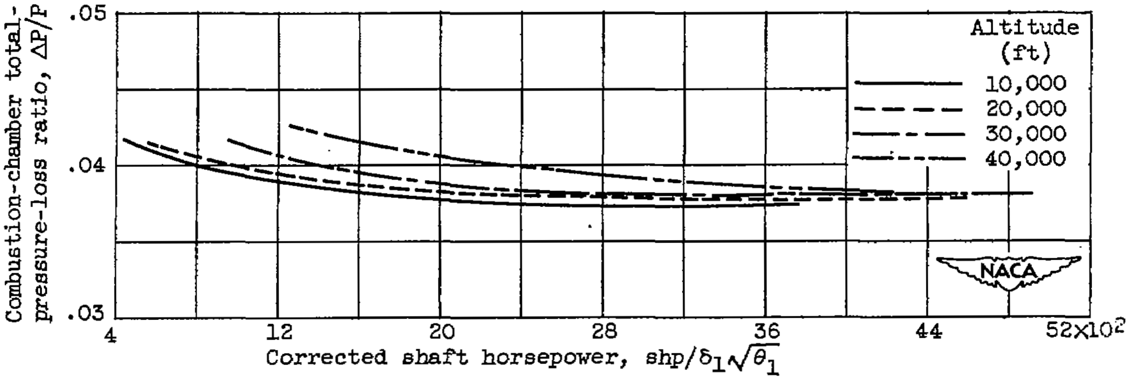
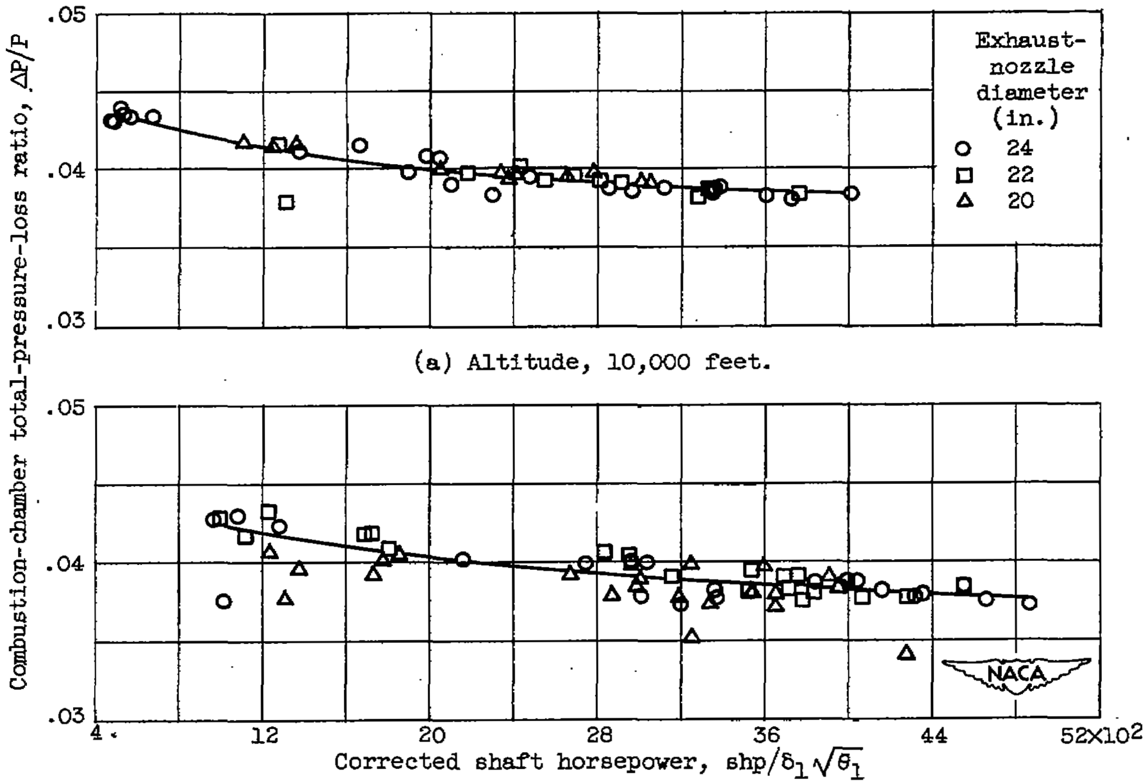


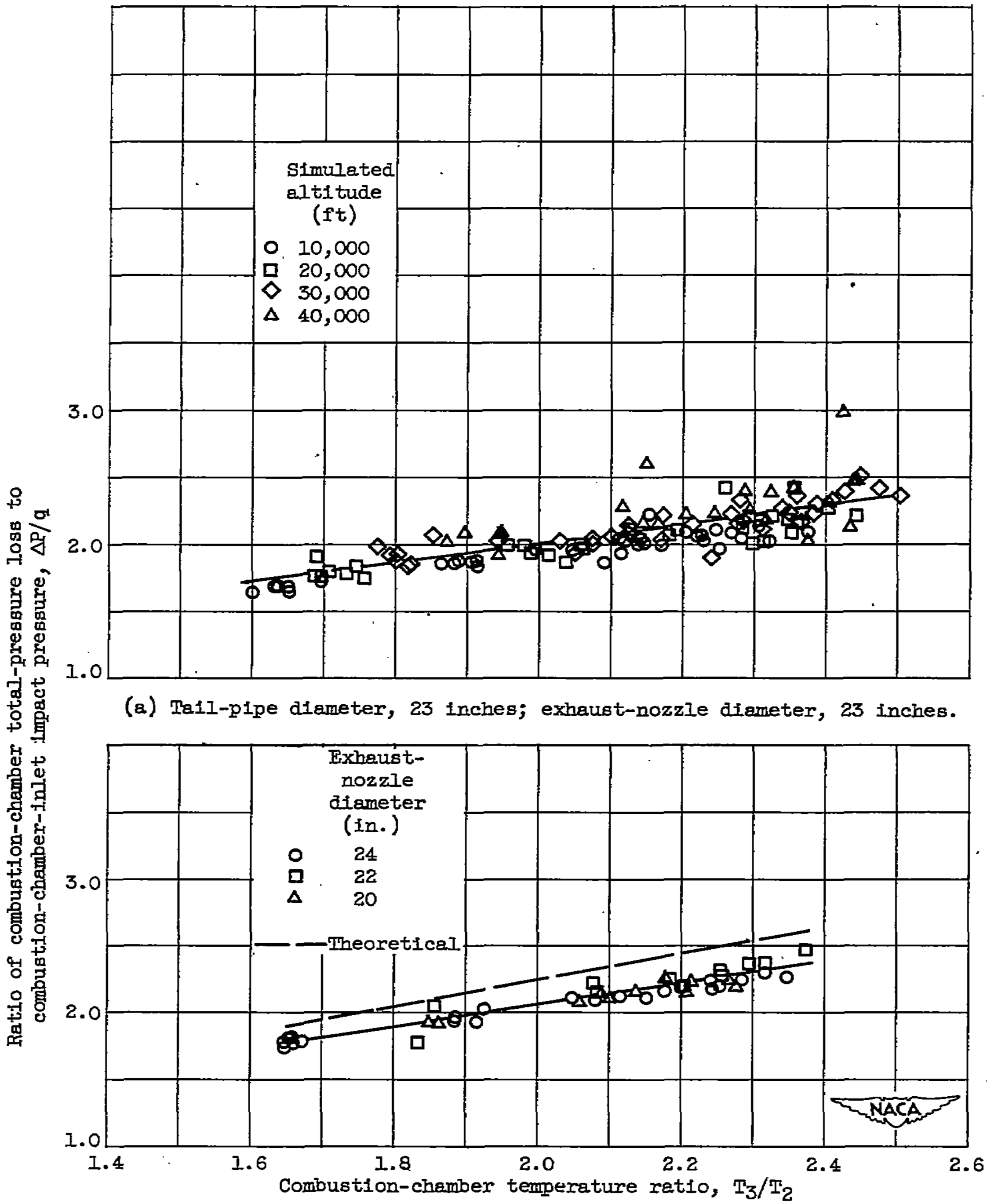
Figure 12. - Effect of corrected shaft horsepower and altitude on combustion-chamber total-pressure-loss ratio of engine with standard tail pipe.



(a) Altitude, 10,000 feet.

(b) Altitude, 30,000 feet.

Figure 13. - Effect of corrected shaft horsepower and exhaust-nozzle diameter on combustion-chamber total-pressure-loss ratio of engine with 24-inch-diameter tail pipe at simulated altitudes of 10,000 and 30,000 feet.



(a) Tail-pipe diameter, 23 inches; exhaust-nozzle diameter, 23 inches.

(b) Altitude, 10,000 feet; tail-pipe diameter, 24 inches.

Figure 14. - Effect of combustion-chamber temperature ratio on the ratio of combustion-chamber total-pressure loss to combustion-chamber-inlet impact pressure for various altitudes and exhaust-nozzle diameters.

NACA-Langley - 11-16-51 - 325

SECURITY INFORMATION

[redacted]