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RESEARCH MEMORANDUM

PRELIMINARY RESULTS OF AN ALTITUDE-WIND-TUNNEL INVESTIGATION OF AN AXIAL-FLOW GAS TURBINE-PROPELLER ENGINE

III - PRESSURE AND TEMPERATURE DISTRIBUTIONS

By Robert M. Geisenheyner and Joseph J. Berdysz

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RESEARCH MEMORANDUM

PRELIMINARY RESULTS OF AN ALTITUDE-WIND-TUNNEL INVESTIGATION OF AN AXIAL-FLOW GAS TURBINE-PROPELLER ENGINE

III - PRESSURE AND TEMPERATURE DISTRIBUTIONS

By Robert M. Geisenheyner and Joseph J. Berdysz

SUMMARY

An investigation to determine the performance and the operational characteristics of an axial-flow gas turbine-propeller engine has been conducted in the Cleveland altitude wind tunnel. As part of this investigation, pressure and temperature data were obtained at altitudes from 5000 to 35,000 feet, compressor-inlet ram-pressure ratios from 1.00 to 1.17, and engine speeds from 8000 to 13,000 rpm. Average pressures and temperatures measured at each station in the engine are presented in tabular form for all operating conditions. The effects of engine speed, shaft horsepower, and compressor-inlet ram-pressure ratio on pressure and temperature distribution at each measuring station are presented graphically.

Changes in engine speed had no appreciable effect on the circumferential or radial distribution of pressures and temperatures at any of the measuring stations with the exception of the compressor inlet, compressor outlet, and tail-pipe-nozzle outlet. As the engine speed was increased, the radial distribution of total pressure at the compressor inlet became less uniform, whereas the distribution at the tail-pipe-nozzle outlet became more nearly symmetrical with respect to the center of the tail pipe. Large variations in the circumferential distribution of dynamic pressure at the compressor outlet occurred at all engine speeds.

Variations in shaft horsepower did not greatly affect the circumferential or radial distribution of pressures and temperatures at any measuring station except the tail-pipe-nozzle outlet, where the total-pressure distribution became more uniform as the

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engine power was increased. Changes in ram-pressure ratio from 1.00 to 1.09 did not affect the distribution of pressures and temperatures. Flow separation in the upper region of the right wing-duct inlet occurred for some operating conditions and was attributed to high inlet-velocity ratio and rotation of the propeller slip-stream. Losses in total pressure between the compressor outlet and the turbine inlet were approximately 0.9 of the dynamic pressure at the compressor outlet.

INTRODUCTION

An investigation to determine the performance and the operational characteristics of the axial-flow gas turbine-propeller engine has been conducted in the Cleveland altitude wind tunnel. As part of this investigation, pressure and temperature data were obtained at altitudes from 5000 to 35,000 feet, compressor-inlet ram-pressure ratios from 1.00 to 1.17, and engine speeds from 8000 to 13,000 rpm. Performance characteristics of this engine are presented in reference 1 and windmilling characteristics in reference 2.

Typical surveys of total pressures, static pressures, and indicated temperatures at the measuring stations throughout the engine are presented herein. The effects of engine speed, shaft horsepower, and compressor-inlet ram-pressure ratio on these pressure and temperature distributions are briefly discussed. Average pressures and temperatures measured at each station in the engine are presented in tabular form for all the operating conditions presented in reference 1.

INSTALLATION AND PROCEDURE

The main components of the T31 gas turbine-propeller engine are a 14-stage axial-flow compressor, nine cylindrical counter-flow combustion chambers, a single-stage turbine, an exhaust cone, and a two-stage planetary reduction gear (fig. 1). The over-all length of the axial-flow gas turbine-propeller engine is 116 inches and the maximum diameter is about 37 inches. The dry weight of the engine, including piping and all accessories, is 1980 pounds. The engine was installed in a streamlined wing nacelle that was mounted in the 20-foot-diameter test section of the Cleveland altitude wind tunnel. A four-blade Hamilton-Standard superhydromatic propeller with a diameter of 12 feet, 7 inches was installed on the engine (fig. 2).

Air entered the installation through two wing ducts with leading-edge inlets behind the propeller. The vertical center lines of the inlets were located along the wing span at about 80 percent of the blade radius (fig. 3). From the ducts, the air flowed through an annular inlet into the compressor. Air discharged from the compressor was turned 180° before entering the combustion chambers. Hot gases leaving the combustion chambers passed through the turbine nozzles and the single-stage turbine into an annular exhaust cone. The exhaust gases were discharged through a straight tail pipe 96 inches in length and 14 inches in diameter.

The operating limits for static sea-level conditions as established by the manufacturer are:

Turbine speed:	
Maximum overspeed, rpm	13,300
Normal rated, rpm	13,000
Idling, rpm	10,000
Exhaust-gas temperatures (at exhaust-cone outlet):	
Military rating, 5 minutes, °F	1265
Normal continuous rating, °F	1170
Starting and acceleration, °F	1600
Bearing temperatures, °F	250
Vibration:	
At turbine frequency, in.	0.004
At propeller frequency, in.	0.025

A description of the instrumentation installed at each measuring station (figs. 1 and 3) is presented in reference 1. Pressures were measured on mercury, alkazene, and water monometers and were photographically recorded. Temperatures were recorded on two self-balancing potentiometers.

The investigation was conducted at altitudes from 5000 to 35,000 feet and compressor-inlet ram-pressure ratios from 1.00 to 1.17. At each altitude and compressor-inlet ram-pressure ratio, engine speeds were varied from 8000 to 13,000 rpm. The engine shaft horsepower measured at the torquemeter ranged from 70 to 1050 horsepower. Ambient pressures and temperatures were maintained at approximately NACA standard altitude conditions.

RESULTS AND DISCUSSION

The average values of total pressure, static pressure, and indicated temperature at each measuring station are presented in table I for all operating conditions investigated. The effects of engine speed, shaft horsepower, and compressor-inlet ram-pressure ratio on pressure and temperature distributions at each measuring station are shown in figures 4 to 32. All instrumentation except that at the wing-duct inlets was viewed in the direction of air flow.

<u>Effect of engine speed.</u> - A typical over-all average pressure profile through the engine is presented in figure 4 to show the effect of engine speed on the average pressure at each measuring station. When the engine speed was increased from 10,000 to 13,000 rpm at approximately constant tail-pipe temperature, the average pressures at the turbine inlet (station 5) were increased approximately 60 percent, whereas the average pressures at the turbine outlet (station 6) were raised approximately 10 percent. The effect of changing the engine speed from 10,000 to 13,000 rpm on the pressure and temperature distribution at each measuring station is shown in figures 5 to 13 for an altitude of 5000 feet and a compressor-inlet ram-pressure ratio of 1.00. For these engine speeds, the average temperature at the junction of the exhaust cone and the tail pipe was approximately 1500° R.

The wing-duct inlet surveys presented in figure 5 show that at engine speeds of 10,000 and 11,000 rpm very low total pressures were obtained in the upper region of the right wing-duct inlet. These low total pressures apparently resulted from flow separation on the inner surface of the upper lip. Although the inlet-velocity ratios for these operating conditions were above unity, the total-pressure distribution at the left duct inlet was uniform. Flow separation at the right duct inlet was probably caused by a combination of the rotation of propeller slipstream and the high inlet-velocity ratios. At engine speeds of 12,000 and 13,000 rpm, the total-pressure distribution was uniform for both inlets.

At the compressor inlet (fig. 6), the radial pressure profiles were uniform at engine speeds of 10,000 and 11,000 rpm. As the engine speed was increased to 13,000 rpm, the total pressure at the middle portion of the annular passage increased and the static pressure decreased, which indicates that the velocity in this region was higher than at the wall. A reasonably uniform circumferential pressure distribution was obtained at all engine speeds.

A survey of the static pressure through the compressor for several engine speeds is shown in figure 7. Compressor-outlet pressure and temperature distributions are shown in figure 8. Close agreement existed between the total-pressure measurements obtained with tubes located on the struts in the compressor-outlet passage and the center tube of the rakes with the exception of rake 3. A uniform circumferential static-pressure distribution was obtained; however, variations in the total-pressure distribution resulted in a large dynamic-pressure gradient around the compressor-outlet annulus. For each engine speed, the dynamic pressure at rake 2 was approximately three times as great as at rake 1. The circumferential distribution of total and static pressures at the turbine inlet was uniform for each engine speed, as shown in figure 9. Because the compressor-outlet static pressures were uniform and the pressure loss through the combustion chambers was approximately 0.9 of the dynamic pressure at the compressor outlet, the resultant distribution of total pressure at the turbine inlet was uniform.

Turbine-outlet total and static pressures are shown in figure 10 and turbine-outlet indicated temperatures in figure 11. The circumferential distribution of total and static pressures was nearly uniform for the four engine speeds presented. A considerable radial total-pressure variation was observed at rake 3 for engine speeds of 12,000 and 13,000 rpm. In general, the static pressures measured by water static-pressure tubes were lower than those measured by wall static-pressure tubes. With the exception of combustion chambers 1, 7, and 8, the turbine-outlet indicated temperatures were fairly uniform. The large temperature variation among these three combustion chambers probably resulted from uneven fuel and air distribution. Flow-bench tests showed that the fuel nozzle installed in combustion chamber 7 had the highest fuel flow under all conditions investigated, which accounted in part for the highest temperature occurring in that combustion chamber. As the engine speed was increased to 12,000 rpm, the temperature differential at the turbine outlet was decreased; however, at 13,000 rpm a slightly greater differential was observed than at 12,000 rpm. Owing to the effect of radiation on the thermocouples, temperatures measured at the turbine outlet were used only to determine burner ignition and unbalance.

Circumferential distributions of total pressure, static pressure, and indicated temperature measured at the exhaust-cone outlet (fig. 12) were uniform for the range of engine speeds presented. For some conditions, not shown graphically, however, temperature variations as great as 140° were observed. Two thermocouples located at this station were connected in parallel to a gage on the engine control panel to indicate limiting exhaust-gas temperatures. The temperature measured by these thermocouples is not shown in figure 12. Exhaust-gas temperature limits were established at this station by the manufacturer.

The distribution of pressures and temperatures in a vertical plane across the tail-pipe-nozzle exit is shown in figure 13. The total-pressure profile at this station changed with engine speed. It is noted that the distribution of total pressure for the top and bottom halves of the rake was not symmetrical. As the engine speed was increased, the total-pressure profile became more uniform with respect to the center of the tail pipe. In order to obtain accurate measurements both vertically and circumferentially, it would be necessary to make surveys in more than one plane. Temperatures measured at the tail-pipe-nozzle-exit rake agreed reasonably well with the average turbine-outlet temperature, but for some conditions these temperatures were higher than those measured at the junction of the exhaust cone and the tail pipe.

<u>Effect of shaft horsepower.</u> - A typical over-all pressure profile through the engine showing the effect of shaft horsepower is presented in figure 14. Total-pressure, static-pressure, and indicated-temperature distributions at each measuring station are shown in figures 15 to 23 for shaft horsepowers of 425 and 951 at an engine speed of 13,000 rpm. These data were obtained at an altitude of 5000 feet and a compressor-inlet ram-pressure ratio of 1.00.

The change in shaft horsepower had no appreciable effect on the pressure and temperature distributions at the wing-duct inlets and the compressor inlet. An increase in shaft horsepower raised the compressor-pressure ratio as shown by the increase in static pressure for each stage of the compressor stator in figure 17. Inasmuch as choking occurred at the turbine nozzles, the higher fuel flow required to increase the shaft horsepower resulted in a higher turbine-inlet temperature and pressure and consequently a higher compressor-pressure ratio.

The change of power had no appreciable effect on the distributions of pressure and temperature at the compressor outlet, the turbine inlet, and the turbine outlet, as shown in figures 18 to 21. The temperature level at the turbine outlet, however, was raised approximately 200° R with the increase in shaft horsepower (fig. 21). The survey at the exhaust-cone outlet shows a slight change in the circumferential total-pressure distribution (fig. 22). An increase in shaft horsepower resulted in a more uniform distribution of total pressure at the tail-pipe-nozzle outlet (fig. 23).

Effect of ram-pressure ratio. - The effect of ram-pressure ratio on the total-pressure, static-pressure, and indicated-temperature surveys is shown in figures 24 to 32 for compressor-inlet ram-pressure ratios of 1.00 and 1.09 and shaft horsepowers of 340 and 330. These data were obtained at an altitude of 35,000 feet and an engine speed of 13,000 rpm. In general, the variation of compressor-inlet ram-pressure ratio from 1.00 to 1.09 did not have any appreciable effect on the pressure and temperature distributions.

Wing-duct-inlet surveys (fig. 24(a)) show that at a compressor-inlet ram-pressure ratio of 1.00 there was evidence of flow separation in the upper region of the right duct. As was previously discussed, this flow separation is attributed to the rotation of the propeller slipstream and the high inlet-velocity ratio. Higher pressures occurred at the compressor outlet and the turbine inlet when the ram-pressure ratio was increased to 1.09. (See figs. 27 and 28, respectively.)

SUMMARY OF RESULTS

The following results were obtained from an investigation of an axial-flow gas turbine-propeller engine in the Cleveland altitude wind tunnel over a range of altitudes from 5000 to 35,000 feet, engine speeds from 8000 to 13,000 rpm, and ram-pressure ratios from approximately 1.00 to 1.17:

1. Changes in engine speed had no appreciable effect on the circumferential or radial distribution of pressures and temperatures at any of the measuring stations with the exception of the compressor inlet, the compressor outlet, and the tail-pipe-nozzle outlet. As the engine speed was increased, the radial distribution of total pressure at the compressor inlet became less uniform; whereas the distribution at the tail-pipe-nozzle outlet became more nearly symmetrical with respect to the center of the tail pipe. Large variations in the circumferential distribution of dynamic pressure at the compressor outlet occurred at all engine speeds.

2. Variation of shaft horsepower did not greatly affect the circumferential or radial distributions of pressures and temperatures at any measuring station except the tail-pipe-nozzle outlet, where the total-pressure distribution became more uniform with an increase in engine power.

3. The circumferential or radial distributions of pressure and temperature were unaffected by a change in ram-pressure ratio from 1.00 to 1.09.

4. Flow separation, which occurred in the upper region of the right wing-duct inlet for some operating conditions, was attributed to high inlet-velocity ratio and rotation of the propeller slipstream.

5. The total-pressure loss between the compressor outlet and the turbine inlet was approximately 0.9 of the dynamic pressure at the compressor outlet.

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National Advisory Committee for Aeronautics,
Cleveland, Ohio.

REFERENCES

1. Saari, Martin J., and Wallner, Lewis E.: Preliminary Results of an Altitude-Wind-Tunnel Investigation of an Axial-Flow Gas Turbine-Propeller Engine. I - Performance Characteristics. NACA RM No. E8F10, 1948.

2. Conrad, E. W., and Durham, D. J.: Preliminary Results of an Altitude-Wind-Tunnel Investigation of an Axial-Flow Gas Turbine-Propeller Engine. II - Windmilling Characteristics. NACA RM No. E8F10a, 1948.

TABLE I.- PRESSURE AND TEMPERATURE DATA FOR

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
								Left duct inlet			Right duct inlet			Compressor inlet		
Run	Altitude (ft)	Engine speed (rpm)	Shaft horsepower	Ram-pressure ratio, P_2/p_0	Tunnel airspeed, V_0 (ft/sec)	Tunnel static pressure, p_0, (lb/sq ft)	Tunnel temperature, T_0, (°R)	Total pressure, P_1 (lb/sq ft abs.)	Static pressure, p_1 (lb/sq ft abs.)	Indicated temperature, $T_{i,1}$ (°R)	Total pressure, P_1 (lb/sq ft abs.)	Static pressure, p_1 (lb/sq ft abs.)	Indicated temperature, $T_{i,1}$ (°R)	Total pressure, P_2 (lb/sq ft abs.)	Static pressure, p_2 (lb/sq ft abs.)	Indicated temperature, $T_{i,2}$ (°R)
1	5,000	13,000	425	0.99	211	1760	505	1822	1763	502	1822	1776	501	1749	1542	501
2	5,000	13,000	619	.99	210	1760	500	1825	1766	499	1825	1773	500	1752	1545	498
3	5,000	13,000	825	1.00	200	1760	495	1827	1768	496	1827	1774	496	1760	1545	493
4	5,000	13,000	951	1.00	198	1760	503	1827	1769	502	1828	1775	501	1756	1555	500
5	5,000	13,000	1044	1.00	201	1767	499	1839	1773	495	1839	1786	495	1765	1563	494
6	5,000	12,000	334	1.00	193	1767	503	1819	1773	497	1819	1777	498	1763	1608	497
7	5,000	12,000	482	1.00	192	1760	496	1817	1767	495	1816	1773	495	1759	1596	495
8	5,000	12,000	636	1.00	183	1753	492	1809	1761	493	1810	1766	492	1752	1593	489
9	5,000	12,000	824	1.00	169	1760	500	1816	1768	500	1816	1772	501	1757	1591	501
10	5,000	11,000	308	.99	91	1760	498	1783	1754	490	1776	1748	491	1747	1639	493
11	5,000	11,000	446	.99	92	1760	505	1790	1759	498	1779	1747	502	1752	1646	501
12	5,000	11,000	591	1.00	110	1753	506	1790	1757	501	1776	1740	506	1751	1643	502
13	5,000	11,000	739	1.00	130	1767	506	1812	1776	501	1794	1756	505	1770	1659	503
14	5,000	10,000	209	1.00	136	1760	500	1790	1764	492	1790	1767	493	1760	----	493
15	5,000	10,000	302	1.00	149	1760	500	1794	1768	493	1794	1771	495	1765	1684	495
16	5,000	10,000	403	1.00	101	1767	503	1797	1771	492	1787	1762	495	1765	1686	494
17	5,000	10,000	513	1.00	102	1760	509	1794	1768	494	1782	1754	497	1762	1684	497
18	5,000	8,050	57	1.00	81	1760	500	1770	1760	500	1770	1761	500	1759	1729	500
19	5,000	8,100	85	1.00	92	1760	500	1773	1763	500	1773	1764	500	1762	1730	500
20	5,000	8,000	114	1.00	92	1760	500	1775	1764	500	1775	1766	500	1764	1732	500
21	5,000	8,050	144	1.00	101	1760	503	1778	1767	499	1778	1768	499	1767	1735	499
22	15,000	13,000	352	1.00	230	1197	462	1249	1203	465	1249	1208	464	1192	1028	461
23	15,000	13,000	514	1.00	143	1190	468	1246	1200	469	1246	1212	469	1199	1031	467
24	15,000	13,000	733	1.00	223	1190	462	1248	1203	469	1239	1195	469	1191	1037	468
25	15,000	13,000	776	1.00	220	1190	466	775	----	470	----	----	470	----	----	467
26	15,000	13,000	849	1.00	209	1190	463	815	----	467	----	----	461	----	----	461
27	15,000	11,000	103	1.00	198	1190	461	1225	1197	460	1225	1199	460	1191	1096	459
28	15,000	11,000	211	1.00	172	1190	461	1222	1194	463	1222	1196	463	1191	1099	463
29	15,000	11,000	329	1.00	173	1190	465	1225	1200	463	1221	1194	463	1191	1099	463
30	15,000	11,000	411	1.00	167	1197	460	1233	1204	457	1224	1196	457	1201	1105	457
31	15,000	11,000	530	1.00	143	1197	461	1232	1204	455	1220	1189	452	1196	1105	453
32	15,000	10,000	183	1.00	125	1190	465	1211	1193	459	1208	1191	459	1189	1132	459
33	15,000	10,000	260	1.00	106	1190	466	1210	1193	459	1202	1184	460	1188	1135	462
34	15,000	10,000	360	1.00	106	1190	466	1214	1196	460	1203	1185	462	1192	1141	462
35	15,000	10,000	437	1.00	113	1197	466	1225	1208	462	1213	1194	462	1203	1155	462
36	15,000	10,000	172	1.06	342	1190	469	1287	1261	476	1287	1265	476	1263	1207	476
37	15,000	10,000	248	1.06	345	1197	473	1297	1272	475	1297	1275	475	1274	1220	475
38	15,000	10,000	340	1.07	347	1197	471	1300	1276	475	1300	1279	475	1277	1223	475
39	15,000	10,000	422	1.07	358	1190	469	1296	1272	472	1296	1275	472	1273	1219	472
40	15,000	8,000	55	1.00	71	1197	464	1203	1196	454	1202	1195	459	1195	1170	461
41	15,000	8,000	72	1.00	71	1190	464	1198	1190	455	1195	1189	459	1189	1166	461
42	15,000	8,000	93	1.00	71	1190	465	1199	1192	455	1196	1189	460	1190	1167	461

AXIAL-FLOW GAS TURBINE-PROPELLER ENGINE

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Compressor outlet			Compressor outlet elbow			Turbine inlet		Turbine outlet				Exhaust-cone outlet			Tail-pipe-nozzle outlet		
Total pressure, P_3 (lb/sq ft abs.)	Static pressure, p_3 (lb/sq ft abs.)	Indicated temperature, $T_{i,3}$ (°R)	Total pressure, P_4 (lb/sq ft abs.)	Static pressure, p_4 (lb/sq ft abs.)	Indicated temperature, $T_{i,4}$ (°R)	Total pressure, P_5 (lb/sq ft abs.)	Static pressure, p_5 (lb/sq ft abs.)	Total pressure, P_6 (lb/sq ft abs.)	Wall-static pressure, p_6 (lb/sq ft abs.)	Wafer-static pressure, p_6 (lb/sq ft abs.)	Indicated temperature, $T_{i,6}$ (°R)	Total pressure, P_7 (lb/sq ft abs.)	Static pressure, p_7 (lb/sq ft abs.)	Indicated temperature, $T_{i,7}$ (°R)	Total pressure, P_8 (lb/sq ft abs.)	Static pressure, p_8 (lb/sq ft abs.)	Indicated temperature, $T_{i,8}$ (°R)
8260	7973	864	8168	8087	874	7974	7838	2201	1893	1781	1320	1891	1781	1329	1929	1757	1331
8481	8199	869	8408	8329	879	8215	8076	2161	1862	1767	1388	1954	1774	1384	1946	1776	1370
8804	8522	873	8723	8698	884	8541	8399	2126	1842	1748	1486	2028	1784	1444	1952	1768	1449
8792	8518	878	8723	8652	887	8534	8396	2123	1832	1744	1515	2003	1788	1496	1952	1769	1525
9047	8774	874	8981	8913	887	8790	8644	2140	1837	1746	1538	2008	1802	1510	1972	1775	1539
7129	6879	819	7052	6987	829	6891	6773	2090	1877	1783	1269	1836	1788	1261	1894	1756	1276
7471	7223	823	7394	7332	732	7229	7106	2105	1851	1767	1339	1870	1777	1266	1906	1772	1331
7661	7418	828	7593	7523	838	7426	7299	2050	1824	1746	1389	1954	1767	1364	1905	1760	1366
7782	7548	842	7714	7649	852	7553	7424	2061	1823	1746	1528	1973	1784	1495	1920	1767	1529
6051	5847	775	5986	5932	783	5854	5755	1986	1837	1762	1320	1802	1777	1306	1854	1757	1309
6202	6008	788	6144	6093	795	6016	5913	1976	1821	1758	1394	1855	1770	1408	1866	1762	1368
6419	6233	795	6375	6326	802	6242	6136	1958	1800	1741	1484	1894	1767	1466	1859	1757	1458
6715	6534	794	6676	6621	805	6536	6427	1983	1803	1755	1521	1899	1788	1468	1886	1774	1482
5159	4988	724	5107	5069	728	5023	4913	----	----	1758	1269	1781	1774	1245	----	1760	1250
5299	5133	729	5248	5203	737	5139	5054	1935	1817	1758	1345	1797	1770	1394	1838	1762	1334
5447	5291	738	5403	5368	745	5298	5210	1924	1810	1758	1428	1850	1774	1463	1847	1771	1403
5566	5418	748	5528	5484	754	5424	5329	1929	1788	1748	1545	1859	1770	1527	1848	1764	1557
3260	3165	645	3233	3210	651	3167	3112	1825	1802	1760	1456	1772	1760	1401	1790	1760	1399
3374	3282	647	3351	3327	652	3281	3227	1840	1802	1762	1511	1772	1763	1448	1793	1760	1440
3389	3303	651	3365	3344	656	3299	3244	1843	1793	1765	1560	1772	1763	1508	1793	1760	1505
3452	3365	655	3430	3411	661	3365	3309	1844	1791	1760	1614	1776	1763	1566	1795	1760	1548
6140	5927	825	6086	6030	838	5948	5844	1534	1293	1211	1272	1333	1218	1282	1334	1199	1382
6243	6041	837	6196	6143	850	6056	5952	1482	1263	1188	1363	1382	1200	1362	1338	1198	1355
6472	6282	854	6426	6379	865	6298	6195	1484	1253	1183	1495	1378	1218	1465	1343	1197	1497
----	----	850	----	----	864	----	----	----	----	----	1498	----	----	1467	----	----	1497
----	----	846	----	----	860	----	----	----	----	----	1511	----	----	1497	----	----	1517
4372	4215	725	4328	4291	735	4224	4154	1371	1278	1166	1098	1213	1204	1086	1263	1190	1104
4471	4322	738	4432	4393	747	4331	4259	1375	1254	1197	1179	1230	1207	1192	1265	1187	1193
4652	4505	746	4613	4572	755	4513	4438	1376	1235	1184	1279	1283	1200	1300	1276	1194	1275
4622	4471	746	4583	4541	755	4481	4400	1374	1236	1184	1332	1314	1204	1315	1285	1202	1322
5024	4884	753	4990	4953	761	4889	4810	1364	1230	1183	1418	1312	1211	1388	1293	1202	1430
3698	3585	702	3668	3640	710	3590	3527	1321	1240	1199	1308	1223	1197	1290	1241	1189	1285
3799	3690	710	3772	3742	719	3695	3632	1311	1225	1199	1420	1260	1200	1410	1246	1193	1401
3893	3791	722	3869	3841	732	3792	3728	1318	1213	1188	1576	1255	1193	1535	1249	1194	1521
4036	3934	734	4010	3985	745	3936	3871	1317	1216	1199	1676	1276	1211	1669	1262	1203	1631
3694	3579	711	3663	3637	717	3583	3524	1336	1255	1216	1285	1236	1214	1269	1253	1201	1260
3800	3689	717	3770	3742	723	3695	3632	1334	1248	1211	1389	1276	1214	1380	1263	1212	1368
3941	3838	725	3913	3890	731	3910	3777	1339	1235	1211	1521	1276	1221	1472	1271	1214	1470
4092	3991	728	4068	4041	735	3989	3925	1329	1219	1202	1600	1276	1214	1572	1268	1206	1542
2436	2369	608	2422	2408	618	2367	2329	1259	1225	1204	1390	1206	1200	1341	1222	1196	1366
2439	2371	612	2426	2408	620	2373	2333	1256	1216	1195	1441	1201	1193	1400	1216	1189	1400
2476	2414	616	2464	2450	623	2414	2373	1257	1214	1192	1500	1204	1193	1449	1217	1189	1444

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TABLE I.- CONCLUDED. PRESSURE AND TEMPERATURE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
								Left duct inlet			Right duct inlet			Compressor inlet		
Run	Altitude (ft)	Engine speed (rpm)	Shaft horsepower	Ram-pressure ratio, P_2/p_0	Tunnel airspeed, V_0 (ft/sec)	Tunnel static pressure, p_0, (lb/sq ft)	Tunnel temperature, T_0, (°R)	Total pressure, P_1 (lb/sq ft abs.)	Static pressure, p_1 (lb/sq ft abs.)	Indicated temperature, $T_{i,1}$ (°R)	Total pressure, P_1 (lb/sq ft abs.)	Static pressure, p_1 (lb/sq ft abs.)	Indicated temperature, $T_{i,1}$ (°R)	Total pressure, P_2 (lb/sq ft abs.)	Static pressure, p_2 (lb/sq ft abs.)	Indicated temperature, $T_{i,2}$ (°R)
43	15,000	13,000	105	1.06	327	1190	469	1275	1262	476	1275	1264	475	1264	1241	475
44	15,000	13,000	134	1.06	327	1197	471	1283	1270	477	1283	1272	477	1272	1249	477
45	15,000	13,000	158	1.06	326	1197	468	1284	1271	476	1283	1273	475	1273	1251	476
46	25,000	13,000	223	1.00	254	781	438	823	790	435	823	793	433	780	663	433
47	25,000	13,000	335	1.00	236	781	438	822	790	435	818	787	431	780	663	432
48	25,000	13,000	461	.99	227	781	436	822	789	437	814	781	430	777	660	432
49	25,000	13,000	522	1.00	229	781	434	824	791	435	814	781	430	779	664	431
50	25,000	13,000	587	1.00	246	788	433	836	802	435	826	791	430	790	672	433
51	25,000	13,000	234	1.08	437	788	456	900	861	465	901	866	465	852	738	465
52	25,000	13,000	394	1.08	437	781	457	896	850	464	894	861	464	847	736	464
53	25,000	13,000	514	1.08	437	788	457	904	861	470	903	868	471	856	743	471
54	25,000	13,000	638	1.07	434	781	463	898	858	463	897	862	462	850	739	464
55	25,000	13,000	384	1.12	504	781	486	924	883	496	923	890	496	876	773	496
56	25,000	13,000	522	1.13	507	774	482	920	879	493	920	884	494	873	764	494
57	25,000	13,000	631	1.13	510	788	474	942	900	488	942	905	488	894	783	488
58	25,000	10,000	71	1.00	152	774	420	790	776	421	790	776	418	774	730	421
59	25,000	10,000	172	1.00	92	781	418	797	784	425	790	775	417	780	738	418
60	25,000	10,000	118	1.09	387	781	442	868	848	450	868	851	450	848	802	450
61	25,000	10,000	174	1.09	387	781	442	868	848	450	868	851	450	849	805	450
62	25,000	10,000	261	1.09	385	781	442	869	849	450	869	852	450	850	808	450
63	25,000	10,000	308	1.09	385	778	438	880	860	450	880	862	450	861	819	450
64	25,000	8,100	36	.99	39	788	420	789	784	425	789	785	425	786	765	434
65	25,000	8,100	56	1.00	75	781	423	787	781	429	785	779	429	780	762	431
66	25,000	8,000	97	1.00	75	781	425	790	785	429	786	780	421	783	767	427
67	25,000	8,000	86	1.09	368	781	440	859	848	445	856	847	445	848	830	445
68	25,000	8,000	122	1.09	370	781	439	860	849	445	857	848	445	849	834	445
69	35,000	13,000	163	.99	229	493	433	516	496	439	514	495	430	487	415	432
70	35,000	13,000	240	.99	238	486	432	512	492	440	507	487	432	482	411	435
71	35,000	13,000	289	1.00	238	493	432	521	500	442	514	493	432	491	417	435
72	35,000	13,000	340	1.00	242	493	430	523	502	440	516	494	431	492	419	434
73	35,000	13,000	381	1.00	239	500	427	530	508	440	522	500	428	499	425	433
74	35,000	13,000	155	1.07	429	493	440	563	537	451	562	539	453	529	452	454
75	35,000	13,000	252	1.09	429	493	440	565	539	450	564	540	452	531	454	454
76	35,000	13,000	330	1.09	435	493	441	567	540	454	565	540	454	531	454	455
77	35,000	13,000	432	1.08	436	493	436	570	543	450	566	540	451	534	457	452
78	35,000	13,000	422	1.09	436	507	442	586	558	449	582	555	450	545	470	451
79	35,000	12,000	134	.98	143	493	425	504	490	429	501	486	421	483	425	428
80	35,000	12,000	209	.98	153	500	425	515	500	429	510	493	424	492	433	428
81	35,000	12,000	276	.99	154	493	430	510	494	430	504	485	422	487	428	426
82	35,000	12,000	341	.99	162	493	428	512	496	436	504	485	425	488	431	431
83	35,000	10,050	163	1.16	506	493	437	590	573	451	584	571	449	573	540	448
84	35,000	10,050	210	1.17	503	493	432	593	579	445	589	574	443	577	548	443

DATA FOR AXIAL-FLOW GAS TURBINE-PROPELLER ENGINE

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Compressor outlet			Compressor outlet elbow			Turbine inlet		Turbine outlet				Exhaust-cone outlet			Tail-pipe-nozzle outlet		
Total pressure, P_3 (lb/sq ft abs.)	Static pressure, p_3 (lb/sq ft abs.)	Indicated temperature, $T_{i,3}$ (°R)	Total pressure, P_4 (lb/sq ft abs.)	Static pressure, p_4 (lb/sq ft abs.)	Indicated temperature, $T_{i,4}$ (°R)	Total pressure, P_5 (lb/sq ft abs.)	Static pressure, p_5 (lb/sq ft abs.)	Total pressure, P_6 (lb/sq ft abs.)	Wall-static pressure, p_6 (lb/sq ft abs.)	Wafer-static pressure, p_6 (lb/sq ft abs.)	Indicated temperature, $T_{i,6}$ (°R)	Total pressure, P_7 (lb/sq ft abs.)	Static pressure, p_7 (lb/sq ft abs.)	Indicated temperature, $T_{i,7}$ (°R)	Total pressure, P_8 (lb/sq ft abs.)	Static pressure, p_8 (lb/sq ft abs.)	Indicated temperature, $T_{i,8}$ (°R)
2514	2449	628	2500	2485	635	2447	2407	1268	1223	1204	1485	1218	1204	1448	1229	1201	1443
2559	2496	635	2549	2532	642	2496	2454	1274	1227	1204	1587	1234	1211	1527	1236	1209	1526
2607	2547	637	2598	2584	644	2549	2505	1271	1221	1206	1669	1241	1211	1554	1237	1212	1569
4279	4129	795	4241	4203	811	4146	4076	1017	852	786	1247	888	795	1236	882	783	1255
4387	4251	804	4357	4322	822	4262	4191	1004	835	781	1324	926	795	1292	891	787	1303
4520	4383	815	4486	4449	832	4421	4321	1017	830	779	1415	929	798	1391	894	786	1429
4557	4420	816	4526	4538	834	4434	4358	1000	829	774	1444	926	798	1436	898	787	1470
3916	3778	815	3883	3851	832	3792	3717	1008	834	776	1488	941	805	1459	909	795	1488
4389	4231	826	4343	4305	840	4242	4171	1053	868	805	1250	912	809	1256	903	802	1259
4527	4384	838	4495	4460	850	4396	4321	1017	844	797	1366	941	813	1347	904	798	1359
4679	4536	833	4651	4611	858	4551	4477	1029	848	795	1441	940	819	1440	915	805	1460
4815	4678	854	4790	4755	864	4694	4618	1013	842	790	1537	952	816	1536	917	798	1538
4398	4255	874	4366	4329	884	4266	4195	1010	845	802	1394	940	845	1373	901	799	1363
4592	4454	879	4565	4526	888	4467	4394	1003	836	786	1499	924	806	1489	900	794	1504
4776	4643	878	4752	4713	887	4652	4576	1018	850	793	1548	954	819	1549	925	809	1548
2551	2470	662	2532	2510	670	2474	2434	882	819	786	1133	793	777	1116	812	773	1109
2821	2749	680	2805	2787	691	2748	2702	885	805	786	1400	835	784	1347	827	784	1345
2641	2558	681	2622	2601	689	2561	2517	900	834	807	1161	821	802	1145	830	792	1133
2744	2661	690	2728	2703	698	2662	2621	895	825	807	1260	844	805	1254	834	793	1239
2871	2792	701	2860	2837	710	2794	2749	898	812	797	1417	849	802	1385	838	796	1368
2986	2911	711	2962	2921	722	2901	2863	897	817	802	1502	869	809	1531	850	804	1473
1678	1631	589	1670	1658	599	1632	1604	830	810	793	1546	793	791	1259	806	787	1255
1732	1684	595	1726	1714	603	1688	1660	828	797	783	1545	793	784	1337	799	780	1323
1815	1775	606	1811	1798	618	1775	1747	830	789	781	1592	804	781	1531	802	783	1520
1840	1793	609	1834	1823	617	1794	1766	842	807	793	1402	811	795	1383	812	792	1365
1908	1864	622	1902	1893	634	1864	1836	844	798	790	1610	818	795	1556	814	794	1503
2768	2681	816	2746	2732	836	2686	2641	648	534	498	1341	578	500	1309	563	496	1313
2838	2753	823	2823	2802	843	2759	2718	638	520	488	1424	576	497	1399	558	490	1423
2929	2844	830	2913	2894	849	2852	2803	640	526	495	1483	587	504	1470	567	497	1509
3002	2914	833	2987	2964	853	2928	2876	637	526	495	1536	595	507	1512	570	498	1545
3068	2984	833	3052	3031	853	2996	2943	644	535	498	1565	608	511	1533	582	505	1548
2849	2753	821	2830	2806	834	2763	2718	659	552	516	1197	601	511	1167	571	502	1162
2983	2893	834	2969	2947	847	2904	2854	654	549	512	1367	594	511	1177	575	503	1281
3082	2992	841	3072	3052	854	3002	2957	657	541	509	1422	601	518	1455	576	504	1387
3223	3132	847	3211	3182	861	3146	3094	652	541	509	1561	620	518	1579	586	505	1500
3233	3174	844	3253	3228	852	3186	3136	676	559	514	1278	627	525	1167	607	519	1474
2476	2397	771	2461	2436	789	2405	2365	611	531	500	1226	567	497	1159	554	495	1155
2597	2517	779	2584	2563	795	2523	2481	620	536	507	1313	568	504	1158	556	503	1199
2654	2579	789	2644	2623	806	2587	2548	613	624	495	1395	567	504	1178	553	496	1422
2751	2679	798	2743	2722	814	2685	2641	606	525	493	1455	577	504	1413	558	497	1530
1950	1895	695	1943	1929	708	1900	1866	580	517	547	1355	583	545	1255	536	504	1298
2075	2027	705	2070	2060	718	2031	1997	579	517	507	1511	561	514	1495	543	506	1490

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Station

1 Wing-duct inlet (fig. 3)
2 Compressor inlet
3 Compressor outlet
4 Compressor elbow
5 Turbine inlet
6 Turbine outlet
7 Exhaust-cone outlet
8 Tail-pipe-nozzle outlet

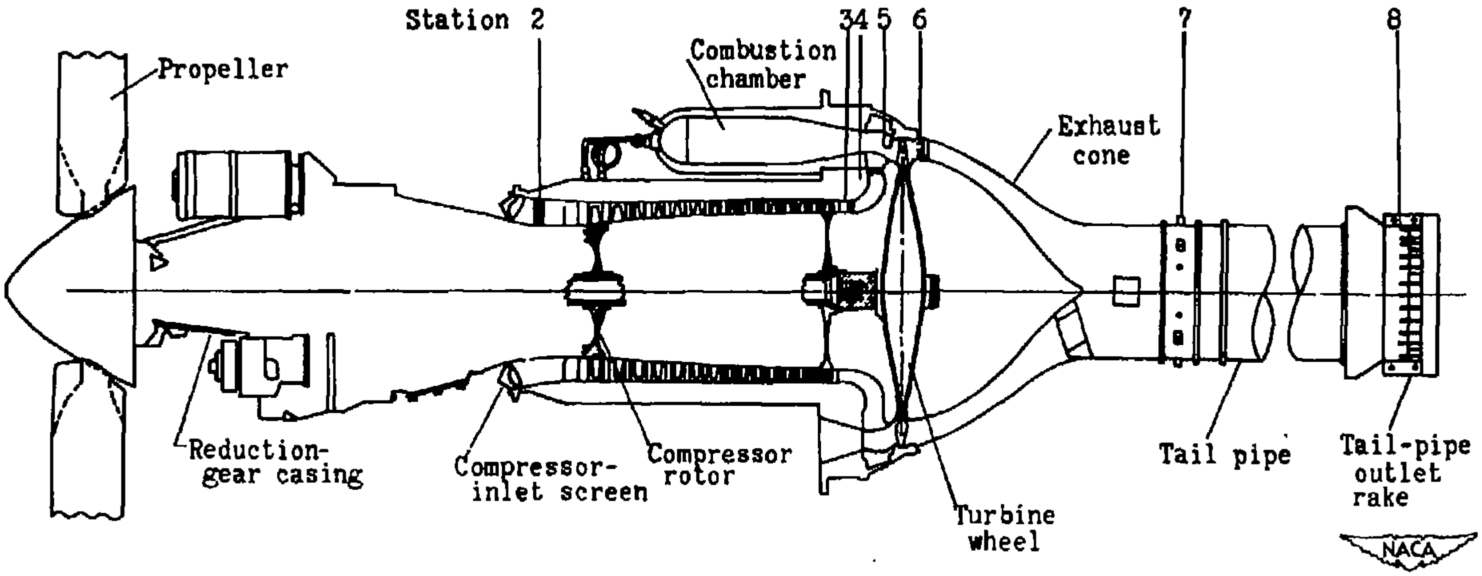

Figure 1. - Side view of axial-flow gas turbine-propeller engine showing location of measuring stations.

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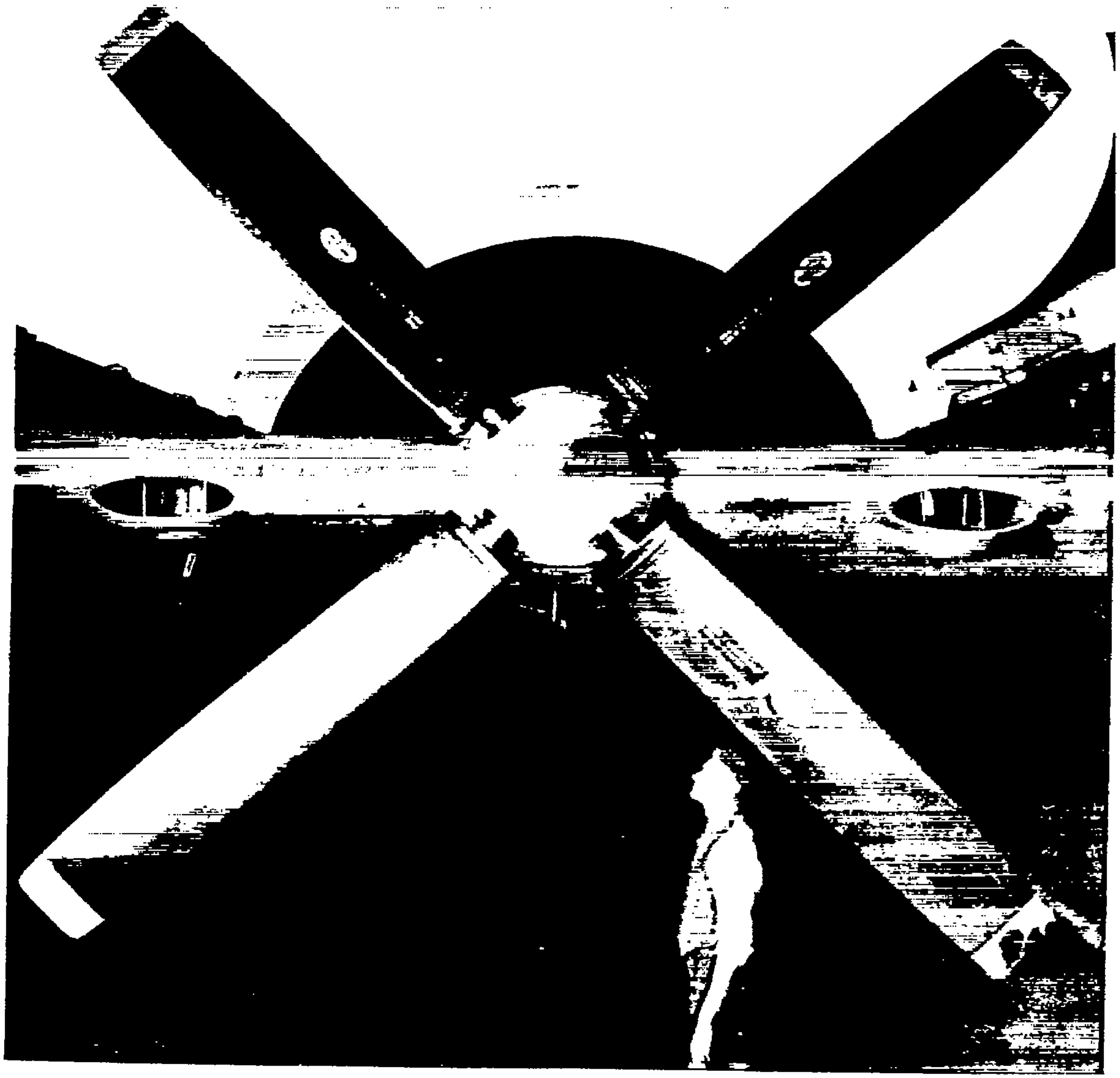

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Figure 2. - Front view of axial-flow gas turbine-propeller engine installation in altitude wind tunnel.

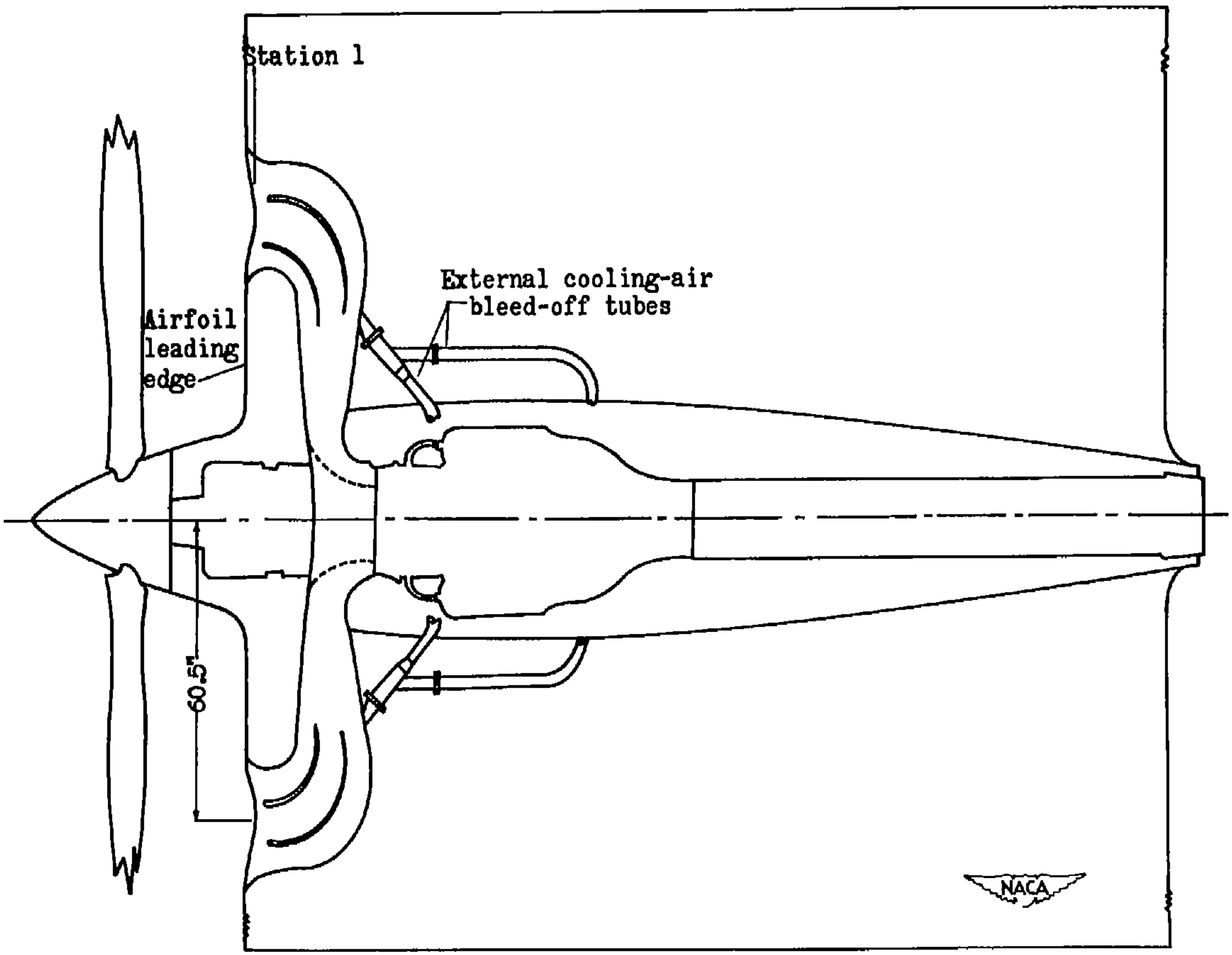


Figure 3. - Sketch of axial-flow gas turbine-propeller engine installation showing location of wing ducts and inlets.

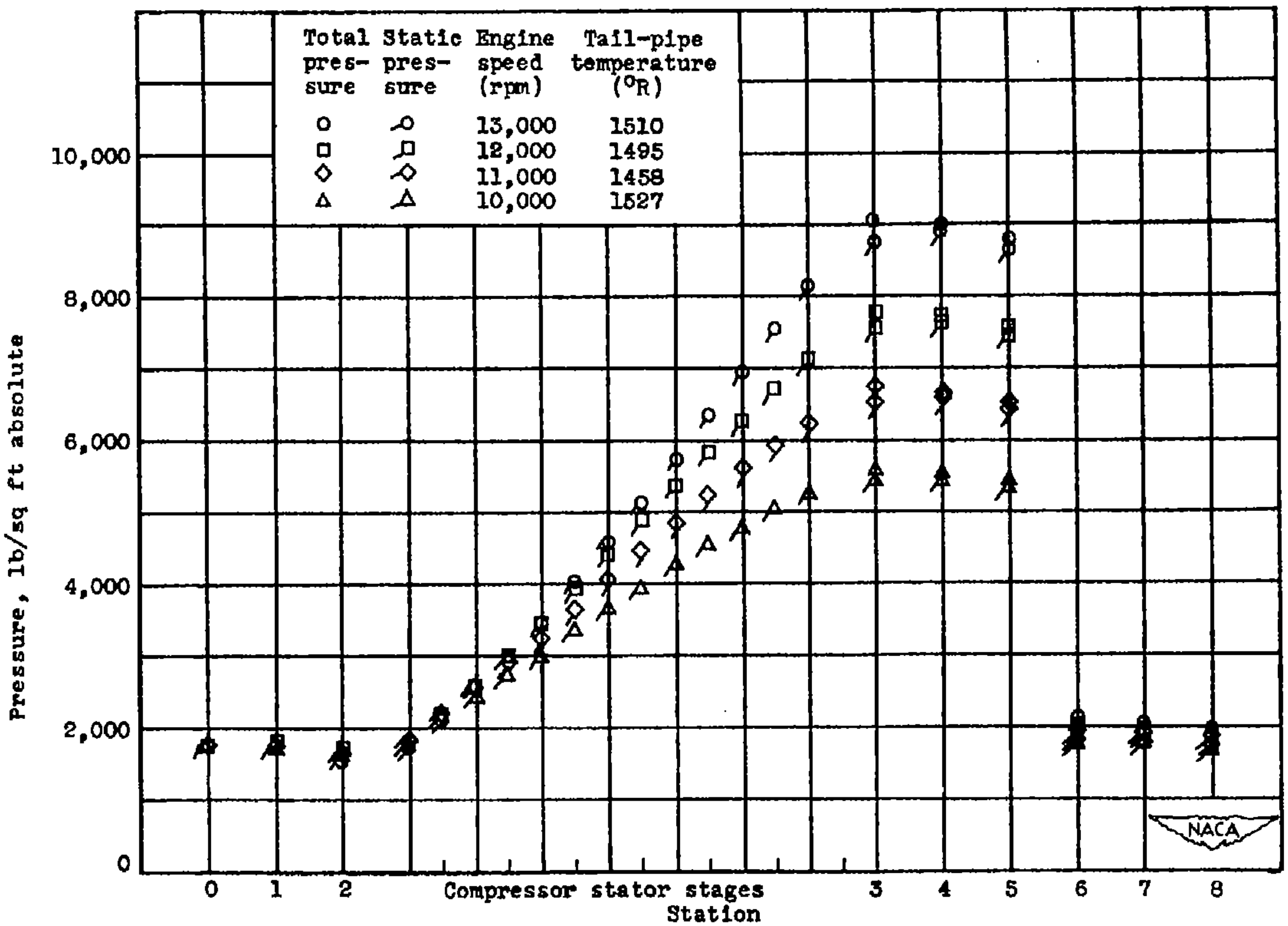
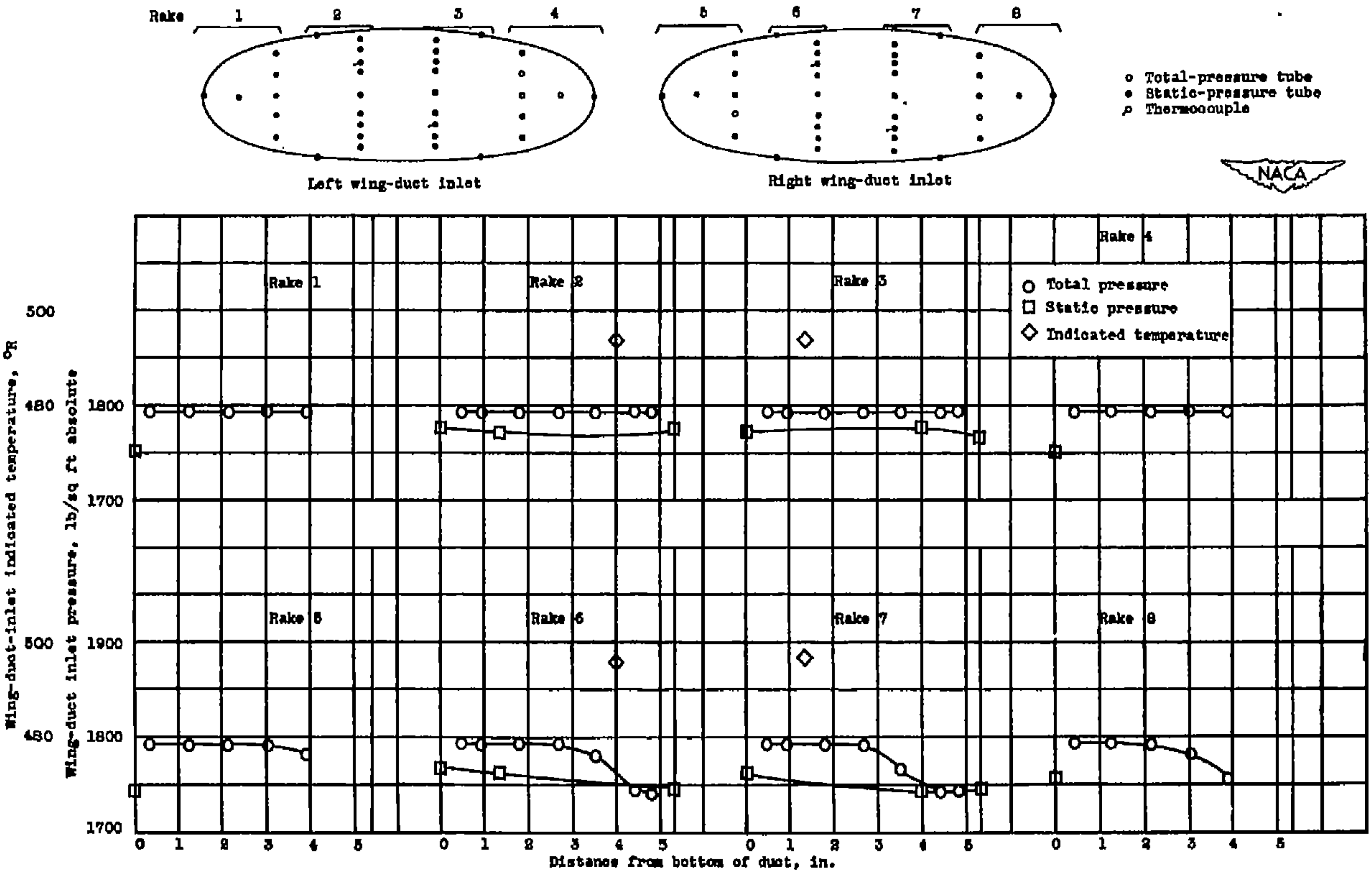
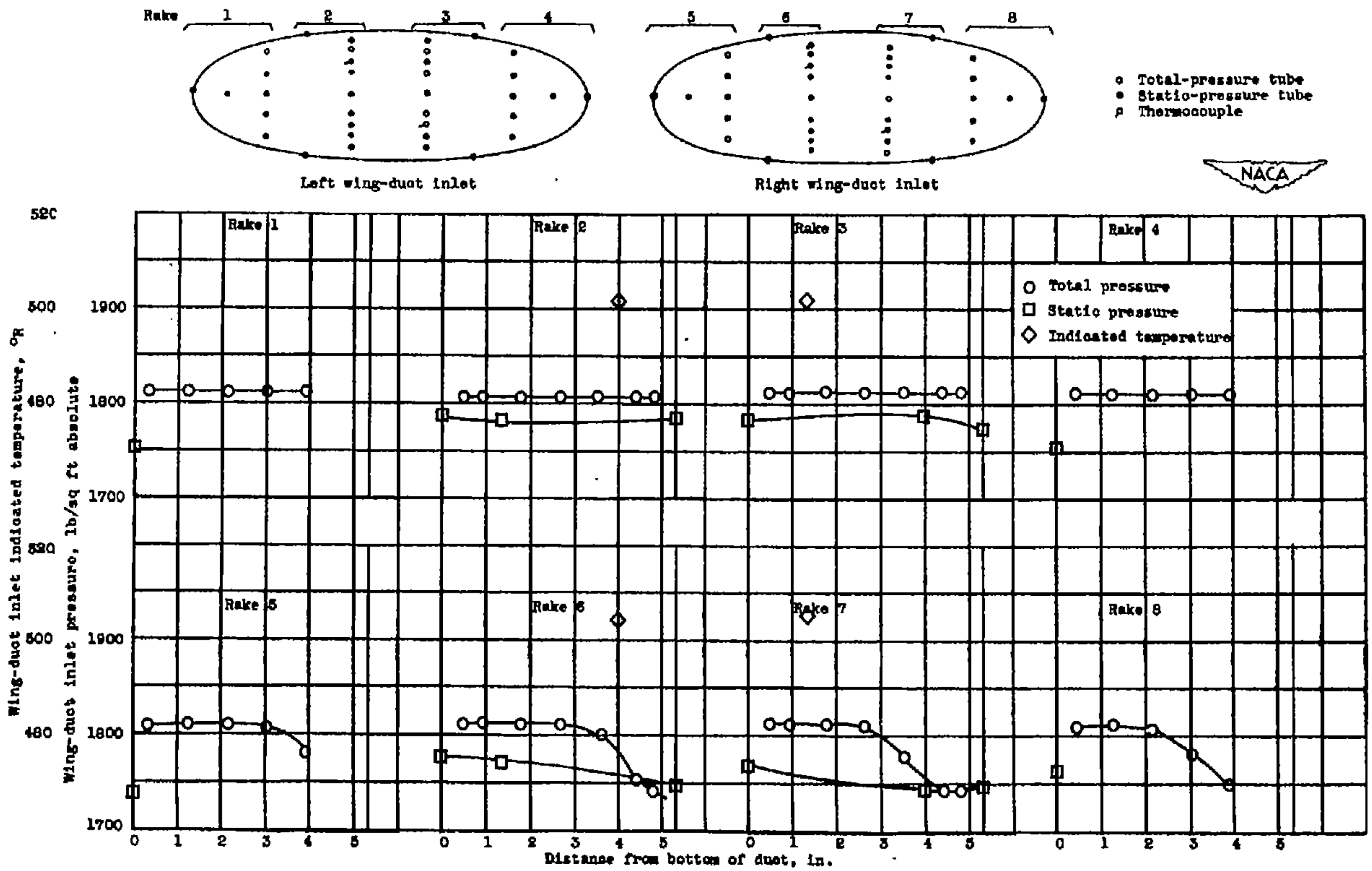


Figure 4. - Typical over-all average pressure profile through axial-flow gas turbine-propeller engine for engine speeds from 10,000 to 13,000 rpm. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.



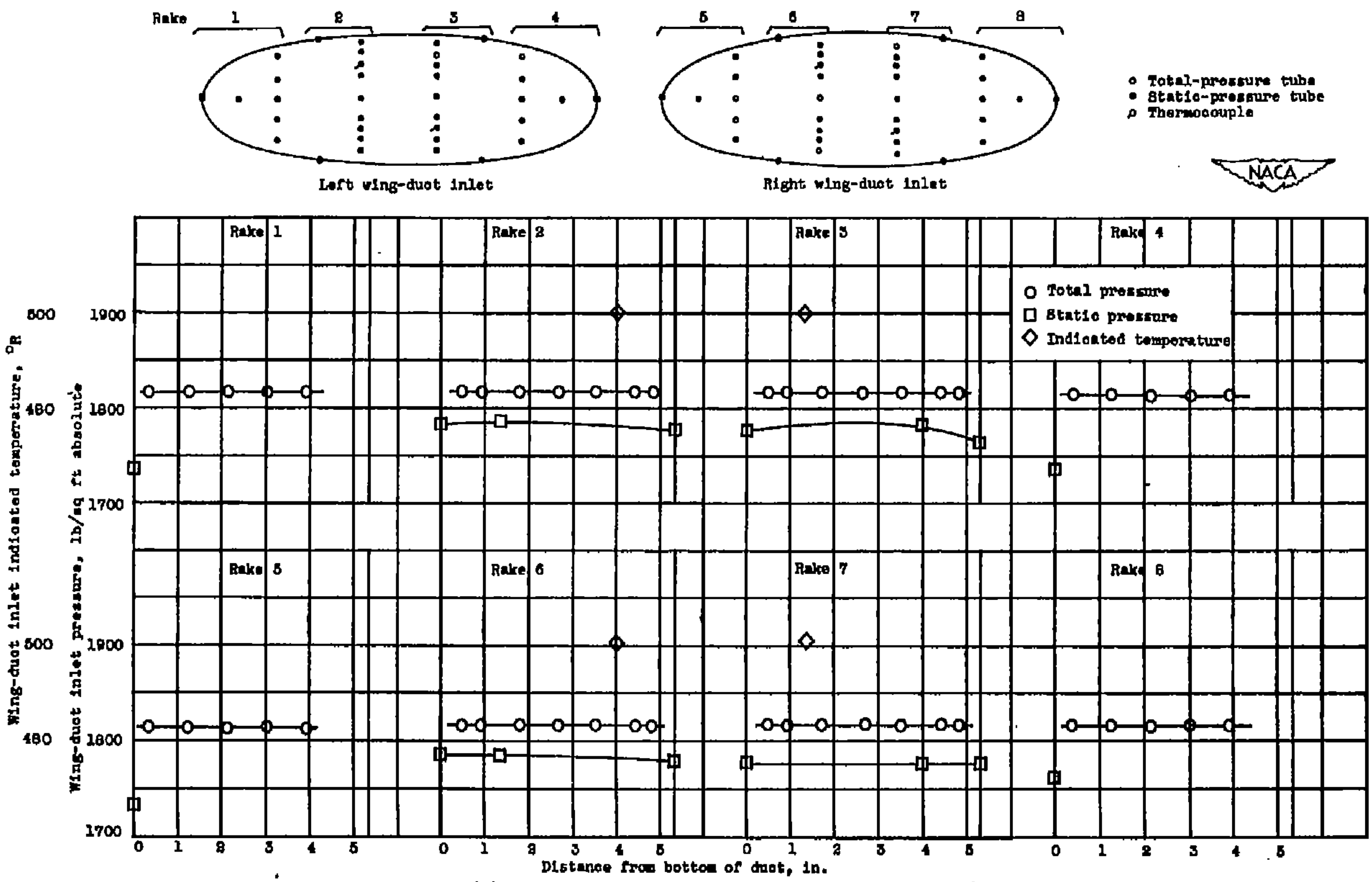
(a) Engine speed, 10,000 rpm; tail-pipe temperature, 1527° R.

Figure 5. - Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at wing-duct inlets. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.



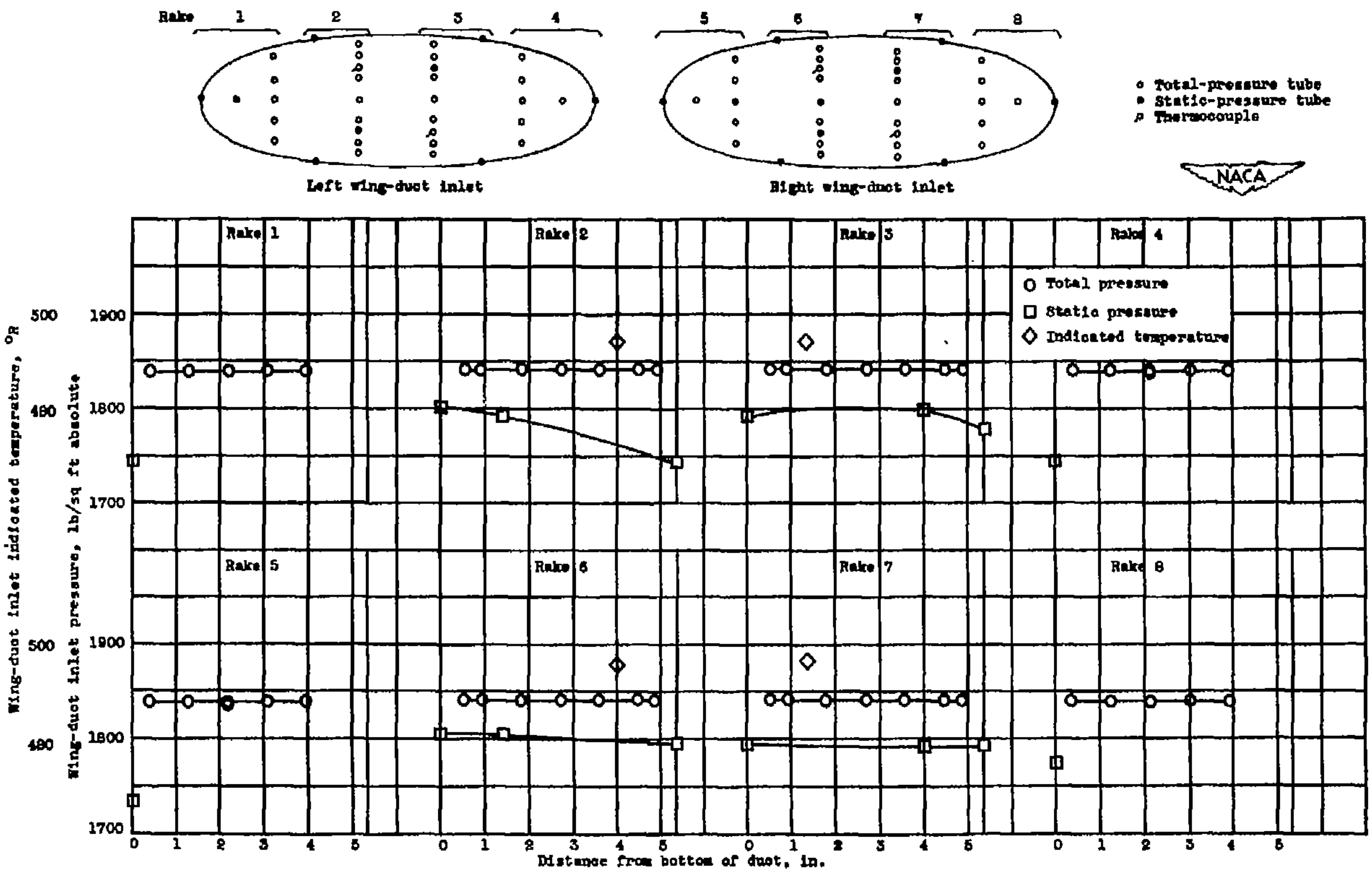
(b) Engine speed, 11,000 rpm; tail-pipe temperature, 1458° R.

Figure 5. - Continued. Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at wing-duct inlets. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.



(c) Engine speed, 12,000 rpm; tail-pipe temperature, 1495° R.

Figure 5. - Continued. Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at wing-duct inlets. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.



(d) Engine speed, 13,000 rpm; tail-pipe temperature, 1810° R.

Figure 5. - Concluded. Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at wing-duct inlets. Altitude, 5,000 feet; compressor-inlet ram-pressure ratio, 1.00.

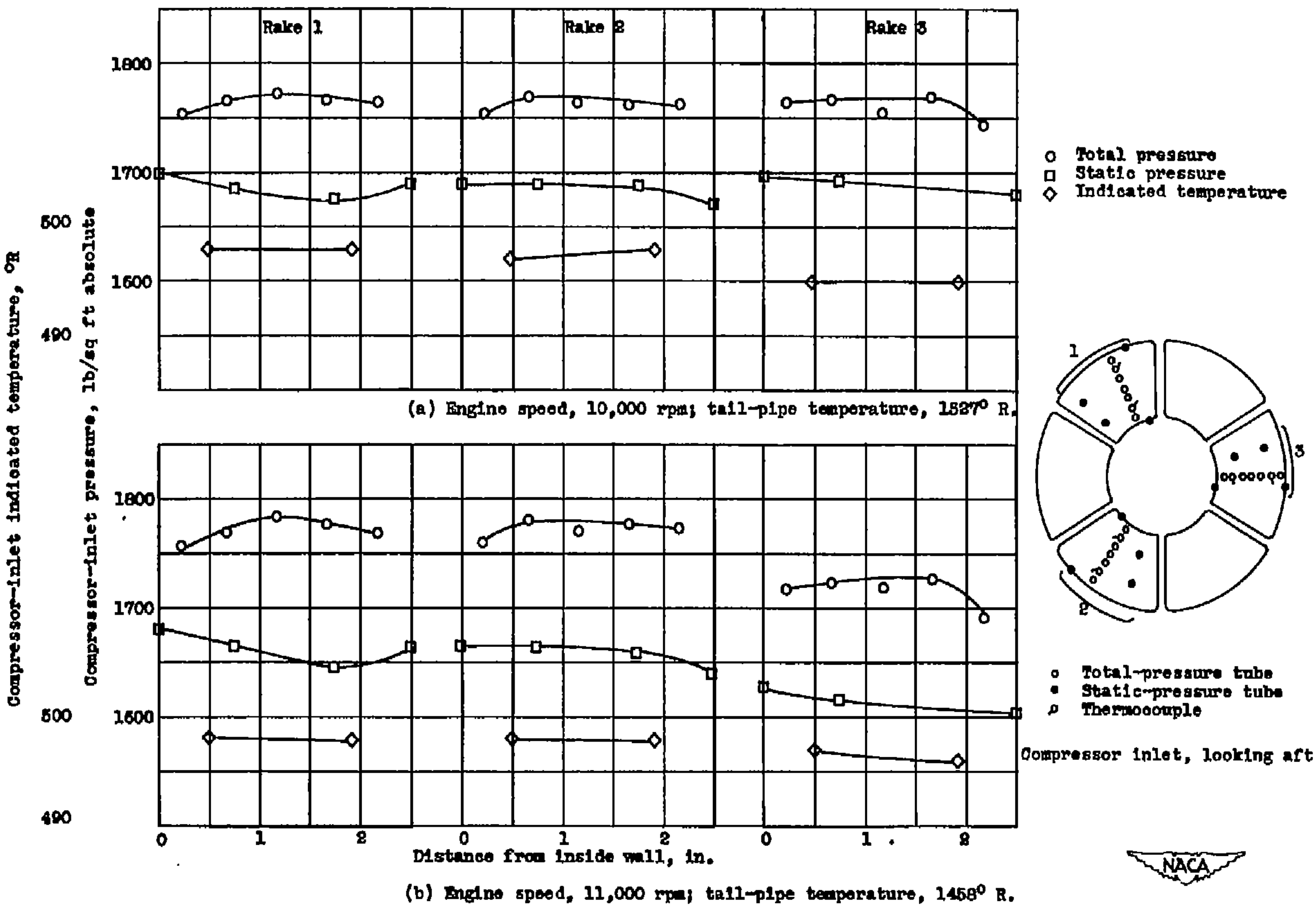


Figure 6. - Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at compressor inlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.

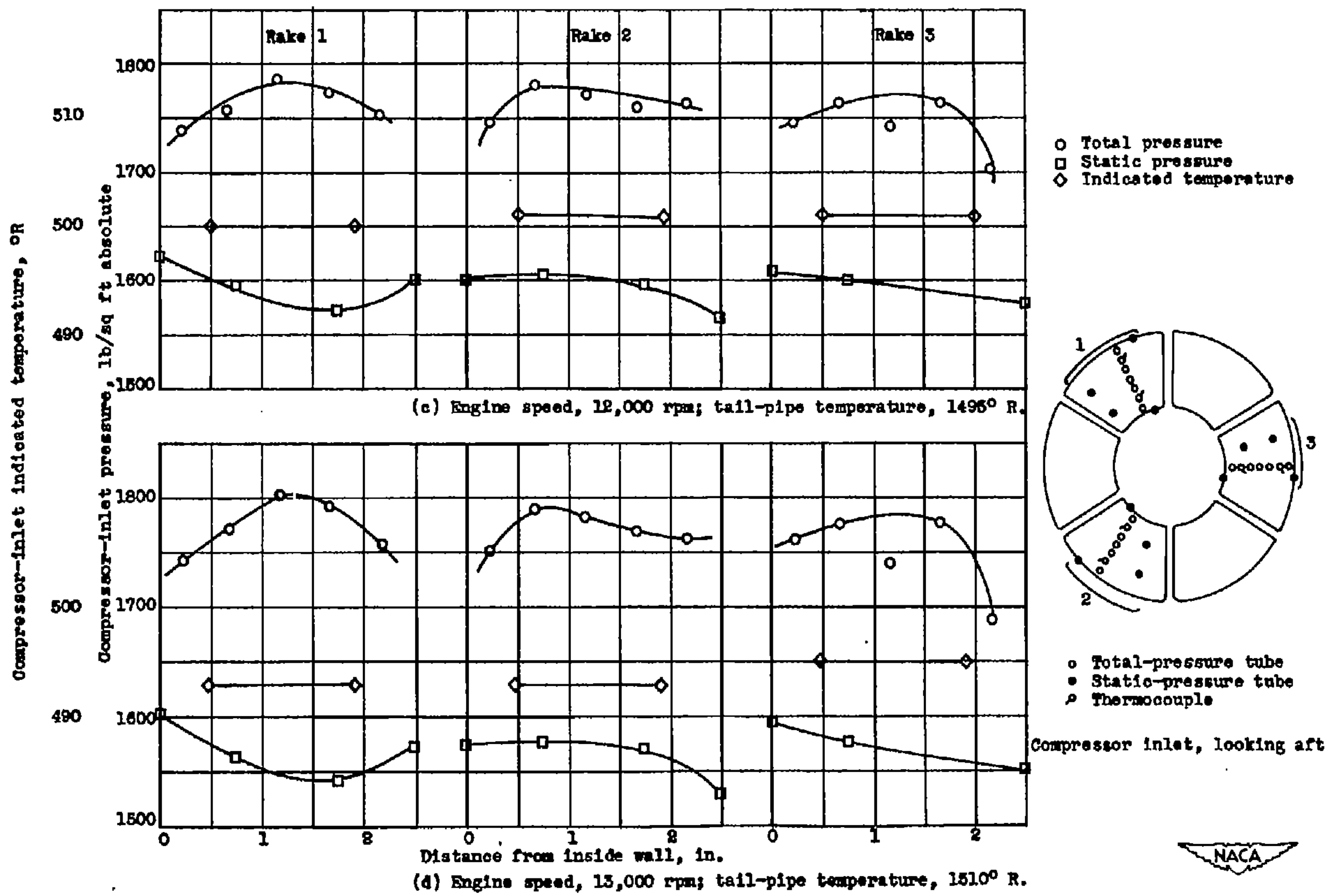


Figure 6. - Concluded. Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at compressor inlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.

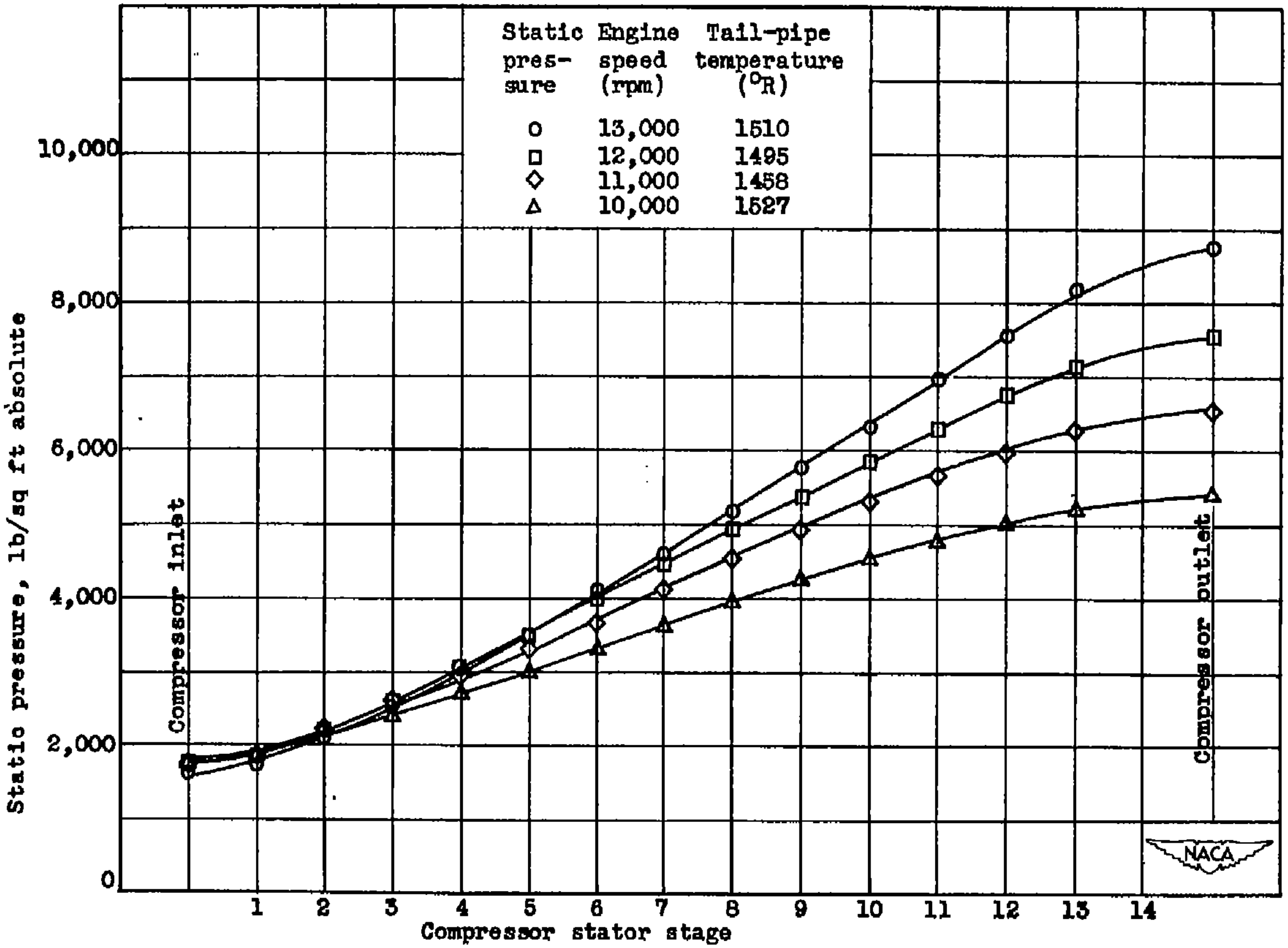


Figure 7. - Effect of engine speed on distribution of static pressure for each stage of compressor stator. Engine speed, 10,000 to 13,000 rpm; altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.

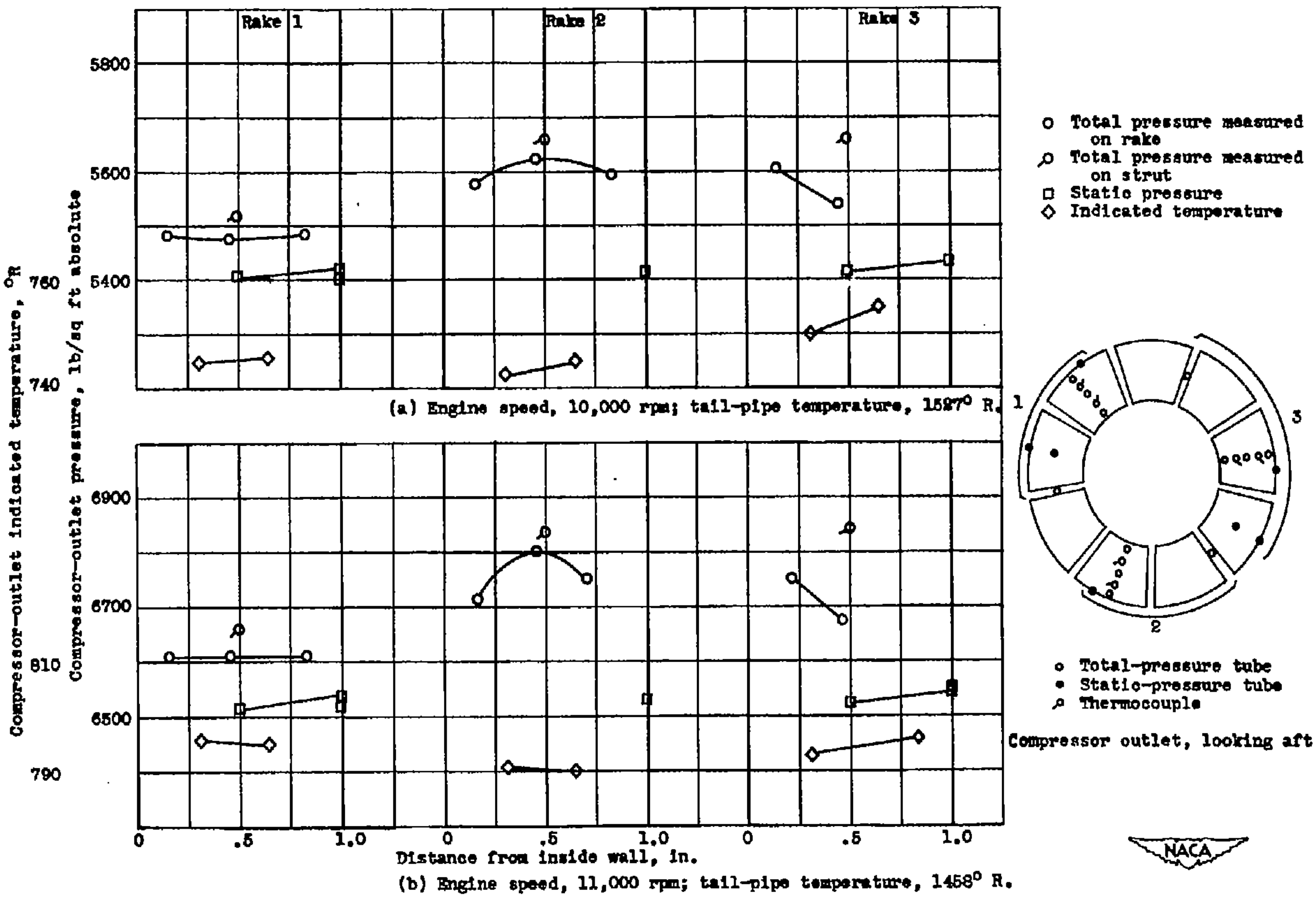


Figure 8. - Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at compressor outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.

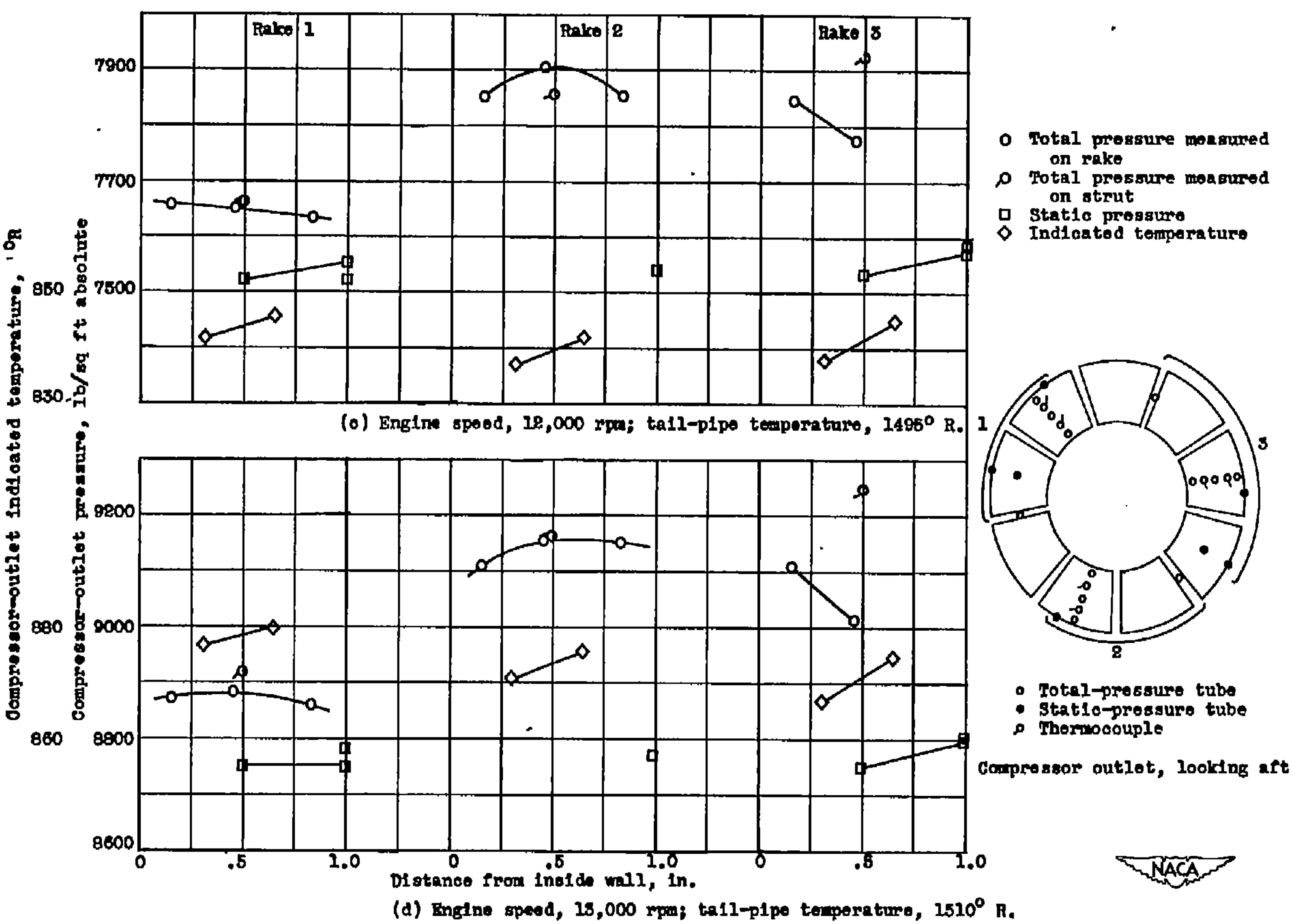


Figure 8. - Concluded. Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at compressor outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.

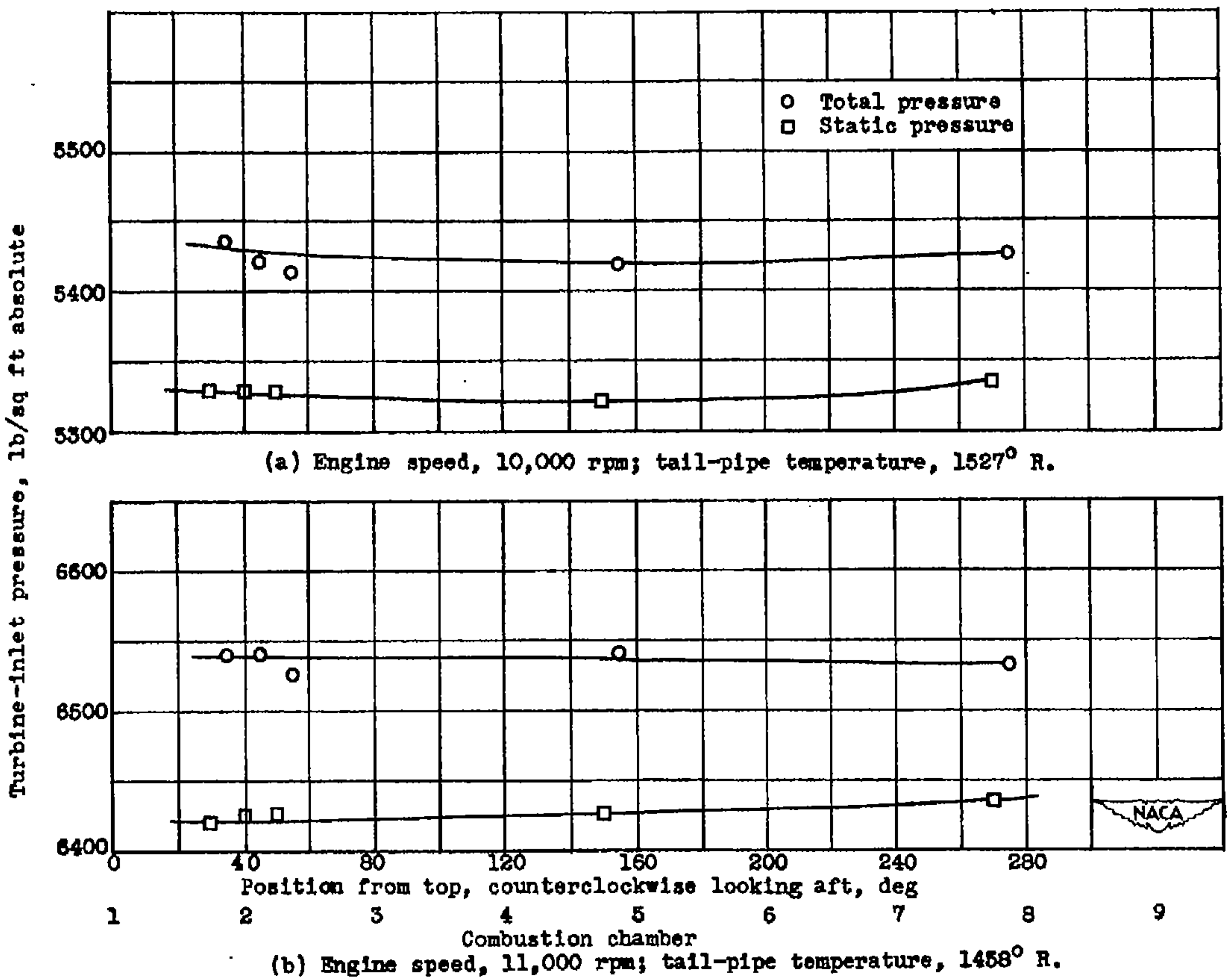
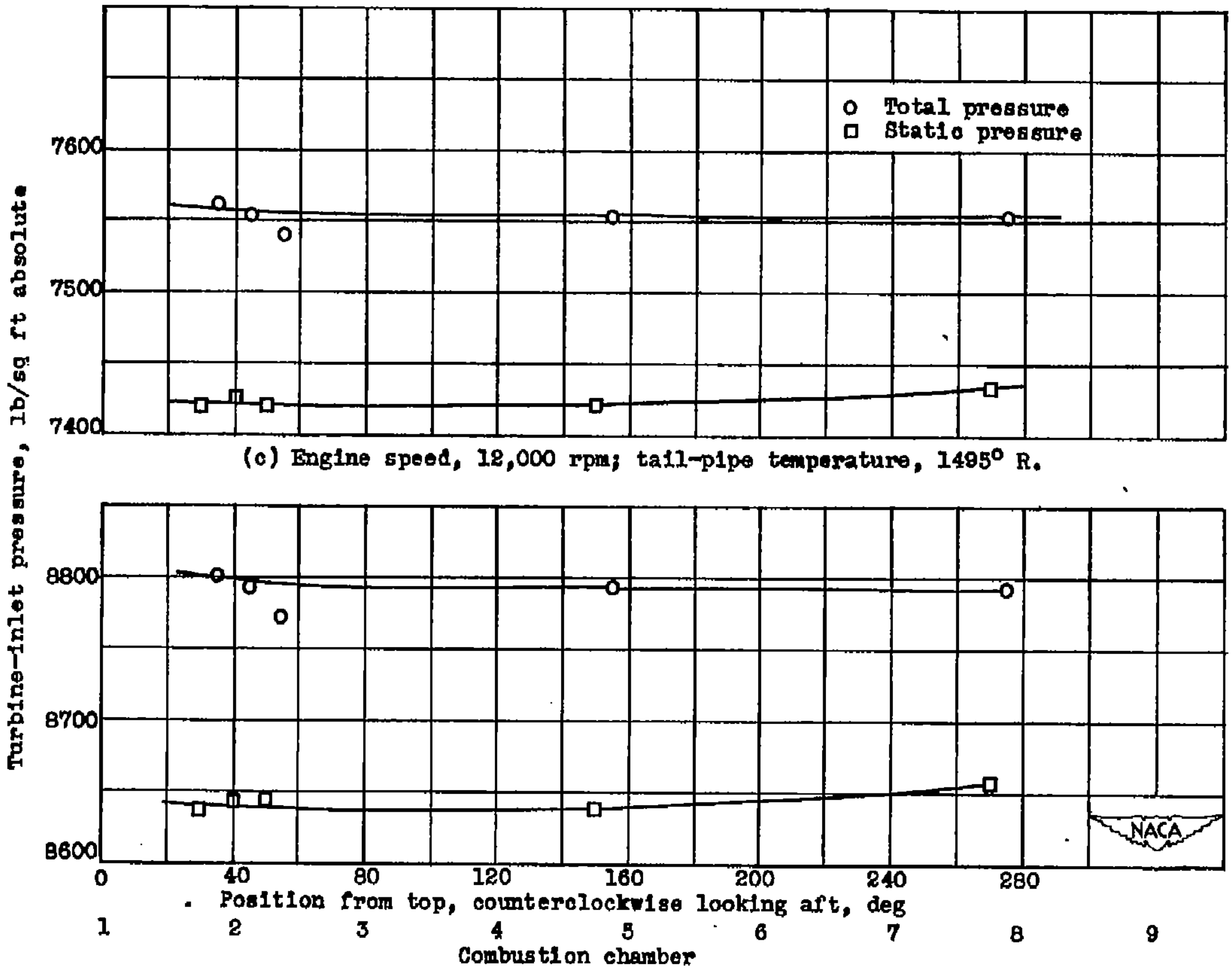


Figure 9. - Effect of engine speed on distribution of total and static pressures at turbine inlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.



(c) Engine speed, 12,000 rpm; tail-pipe temperature, 1495° R.

(d) Engine speed, 13,000 rpm; tail-pipe temperature, 1510° R.

Figure 9. - Concluded. Effect of engine speed on distribution of total and static pressures at tur bine inlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.

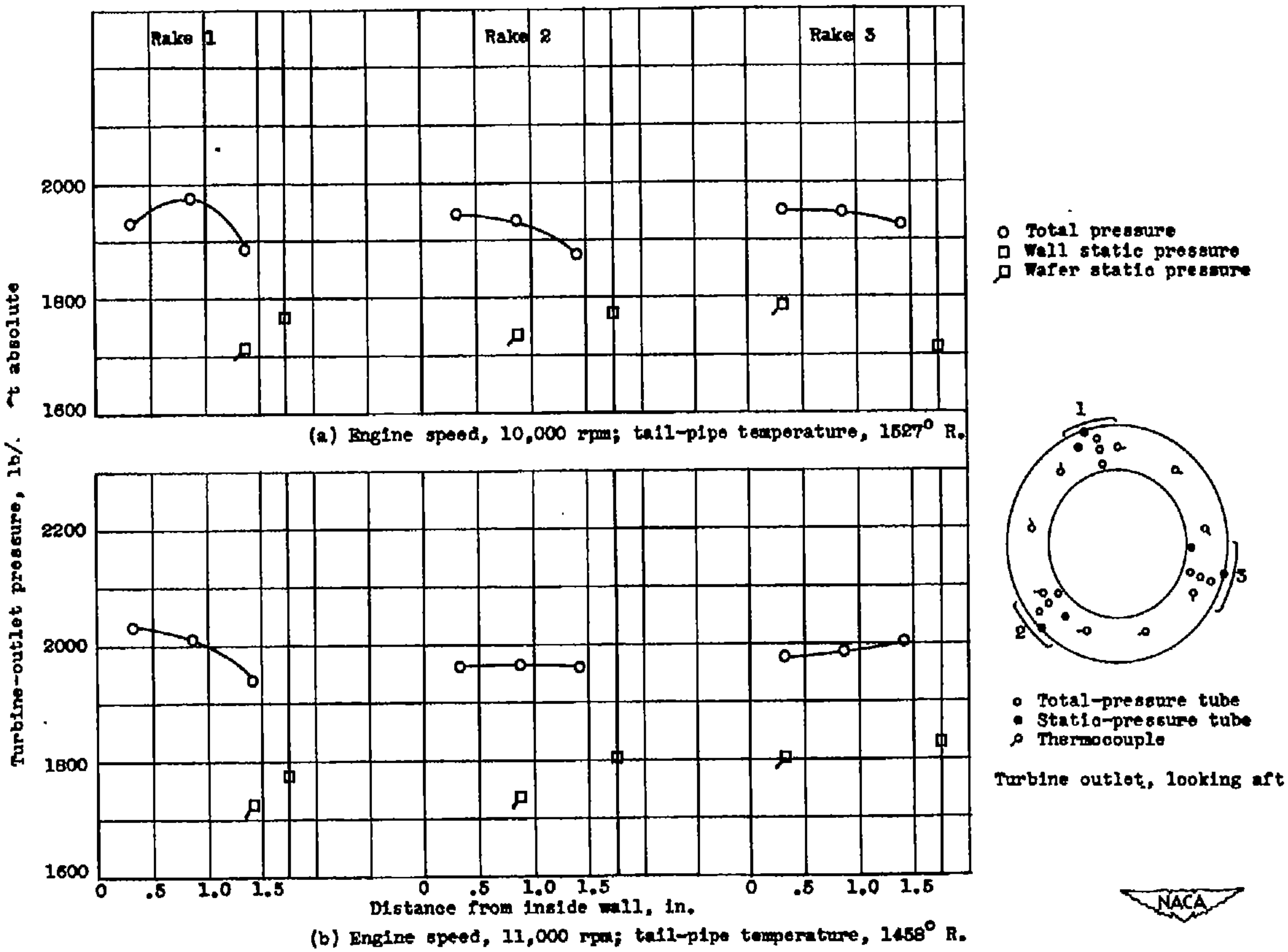


Figure 10. - Effect of engine speed on distribution of total pressure and static pressure at turbine outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.

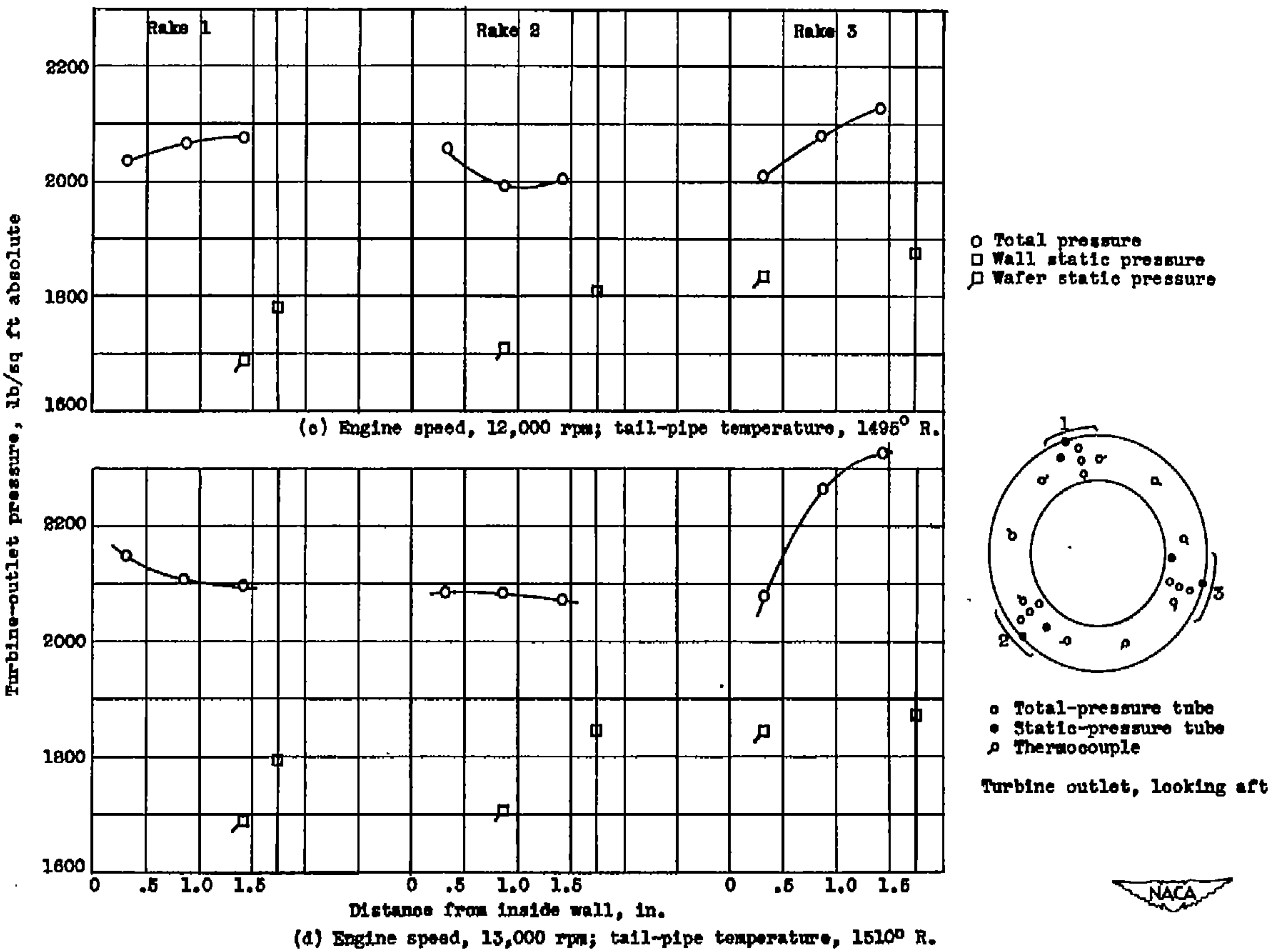
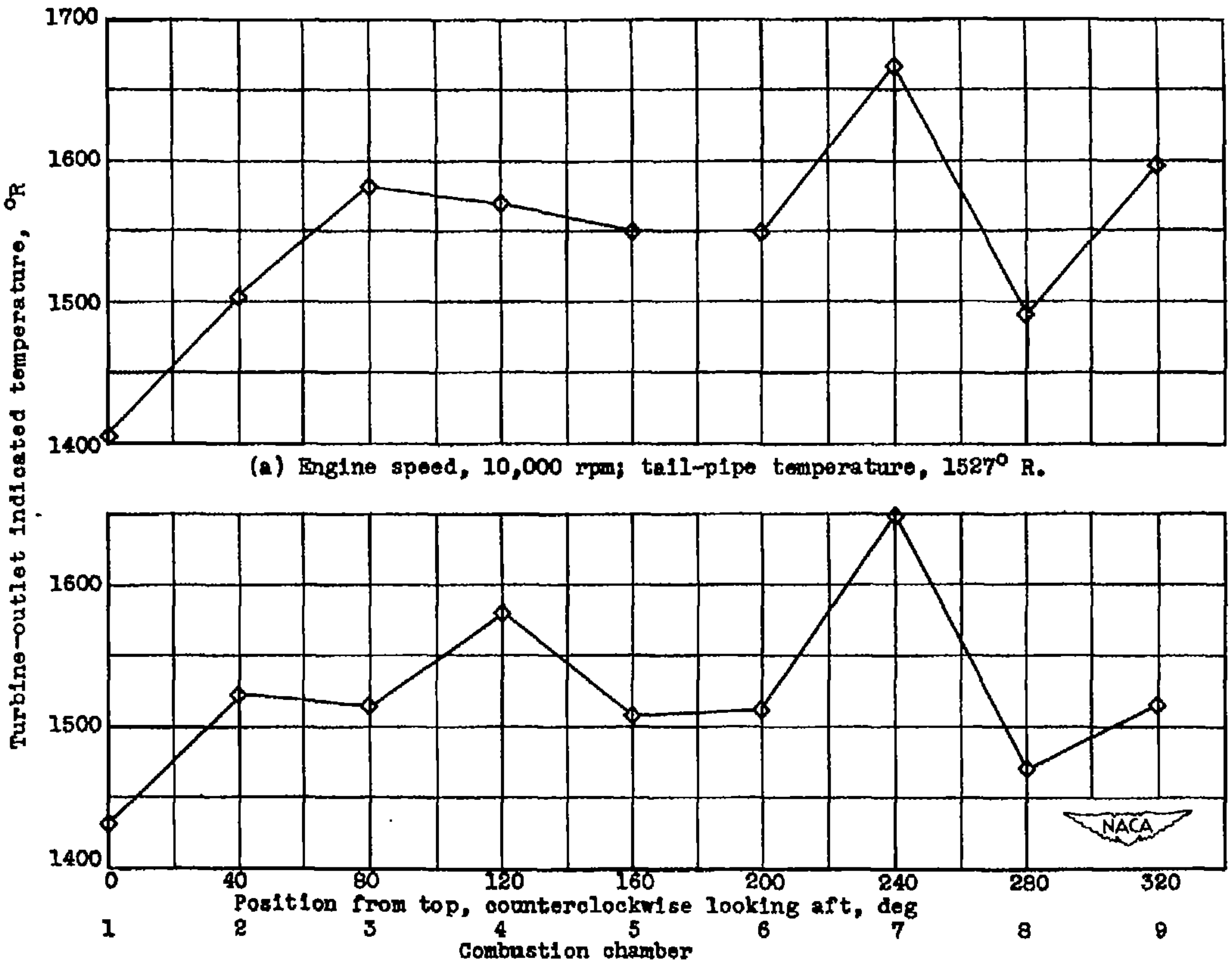


Figure 10. - Concluded. Effect of engine speed on distribution of total pressure and static pressure at turbine outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.



(a) Engine speed, 10,000 rpm; tail-pipe temperature, 1527° R.

(b) Engine speed, 11,000 rpm; tail-pipe temperature, 1458° R.

Figure 11. - Effect of engine speed on distribution of indicated temperature at turbine outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.

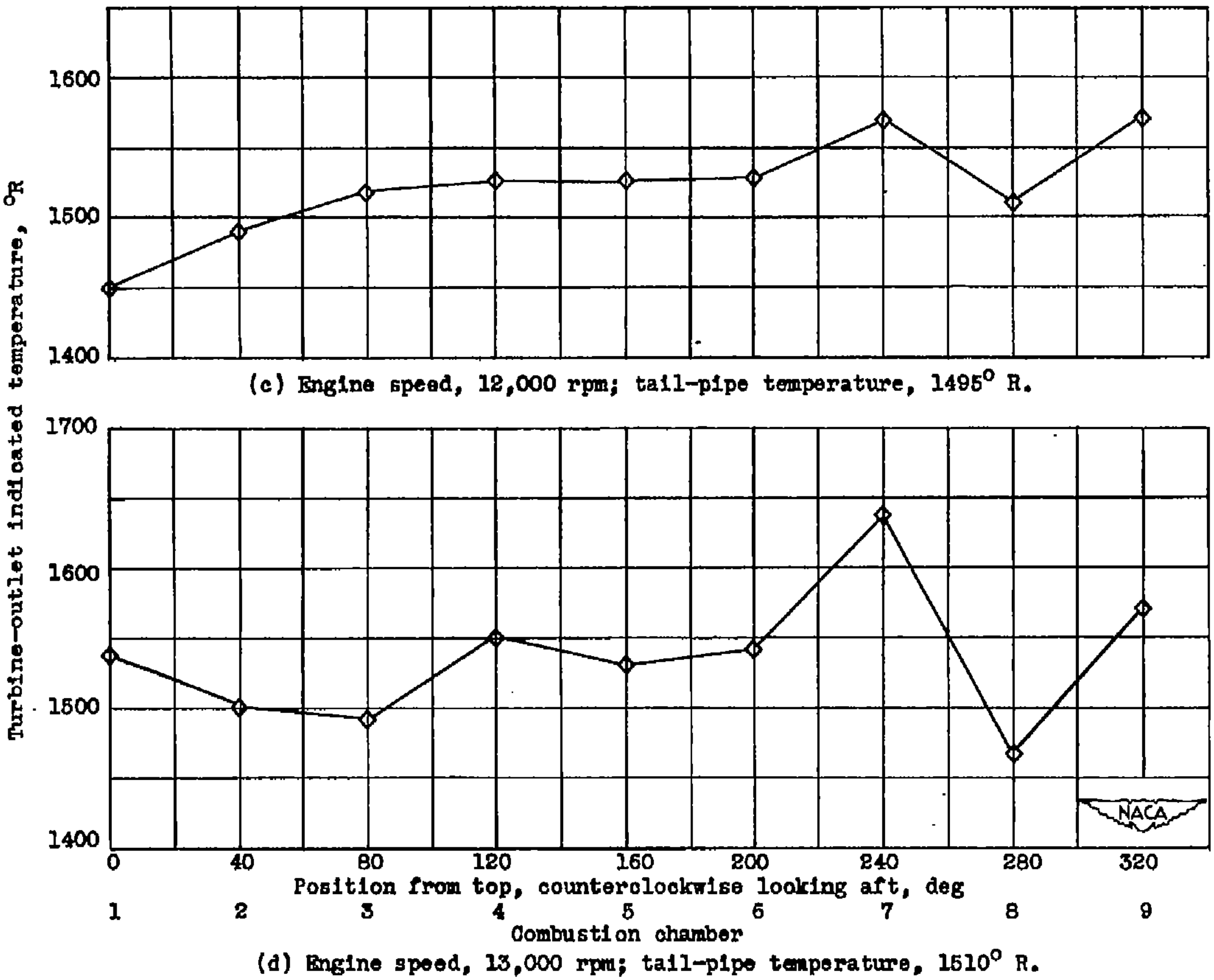
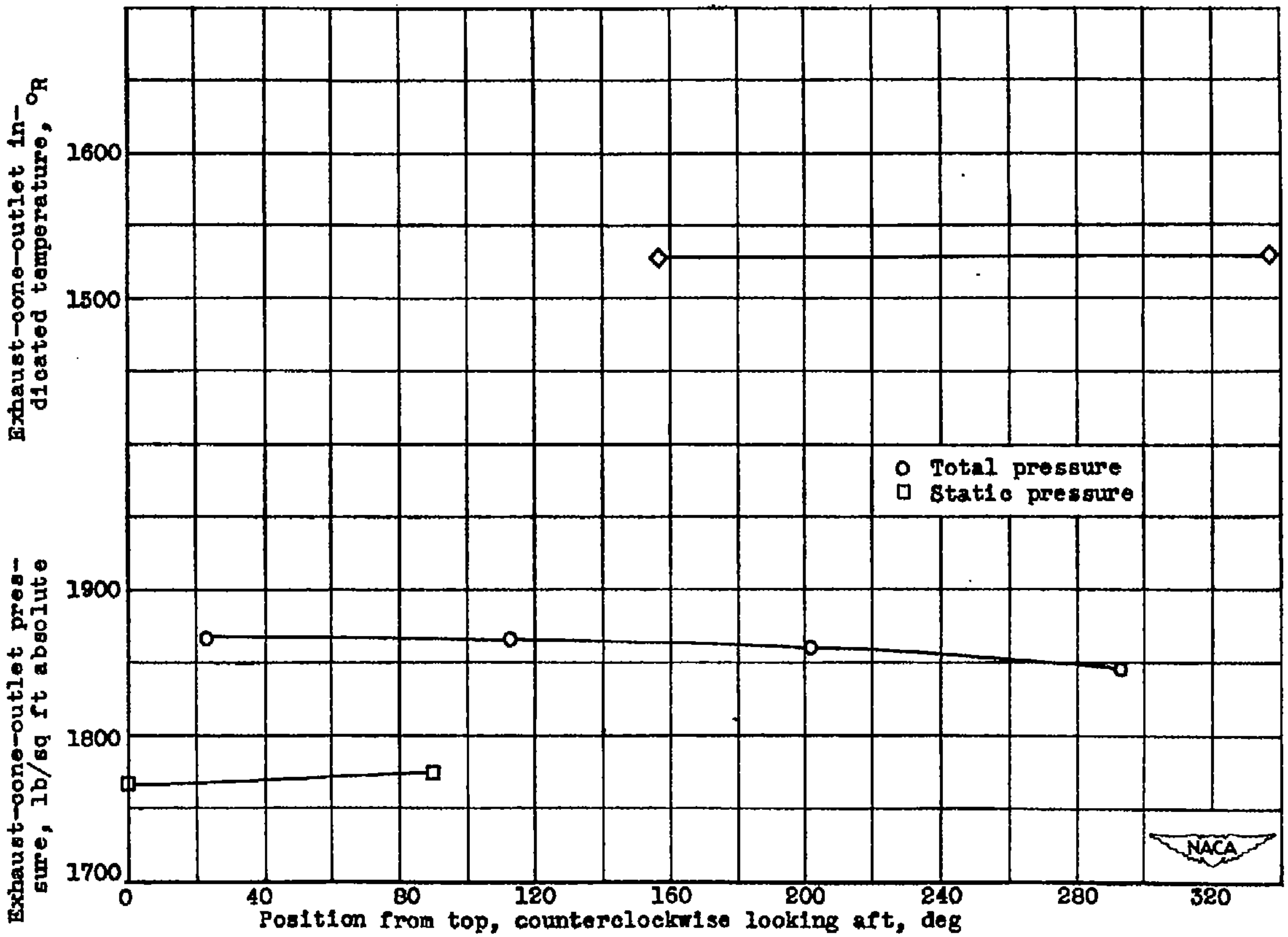
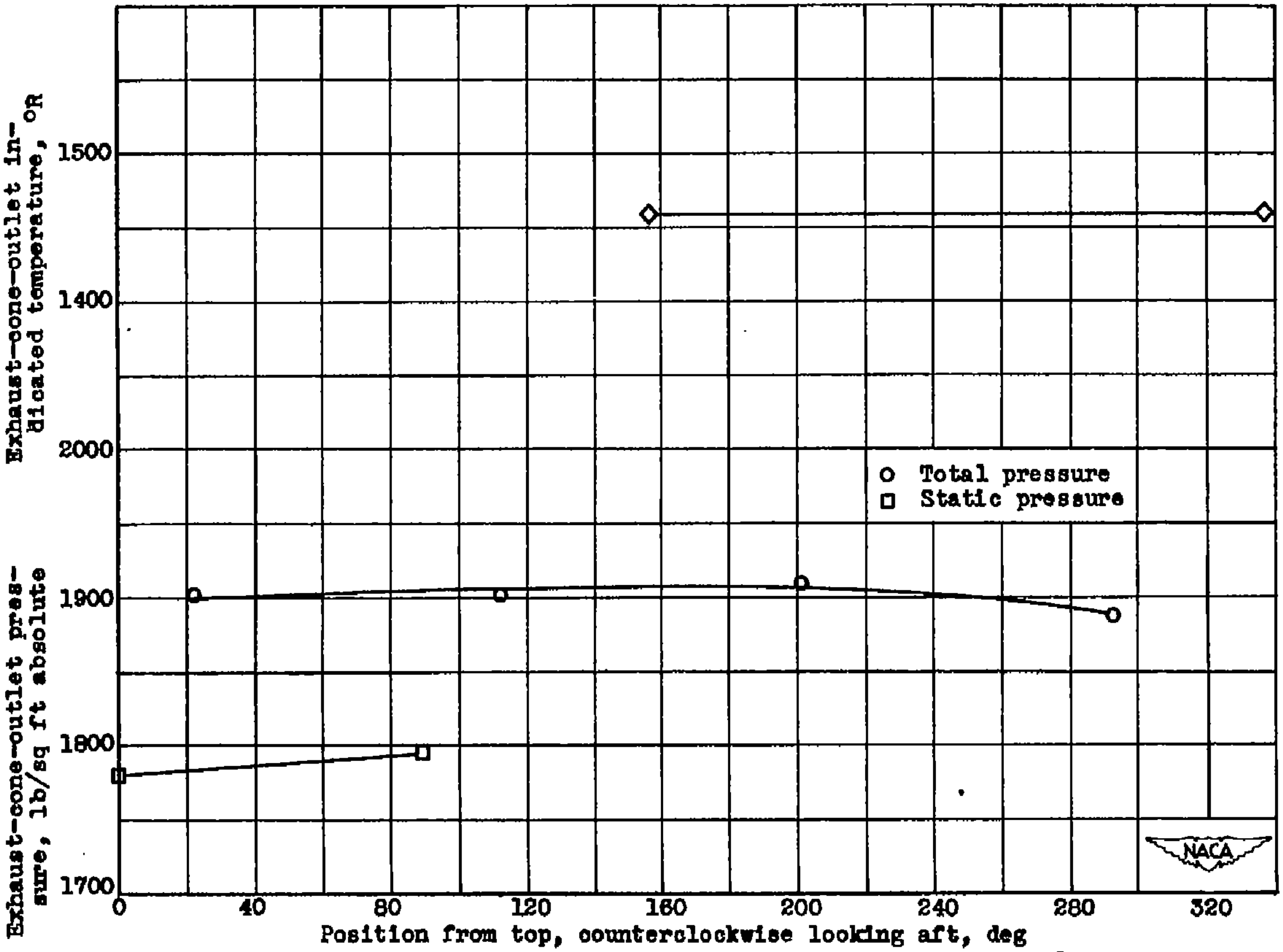


Figure 11. - Concluded. Effect of engine speed on distribution of indicated temperature at turbine outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.



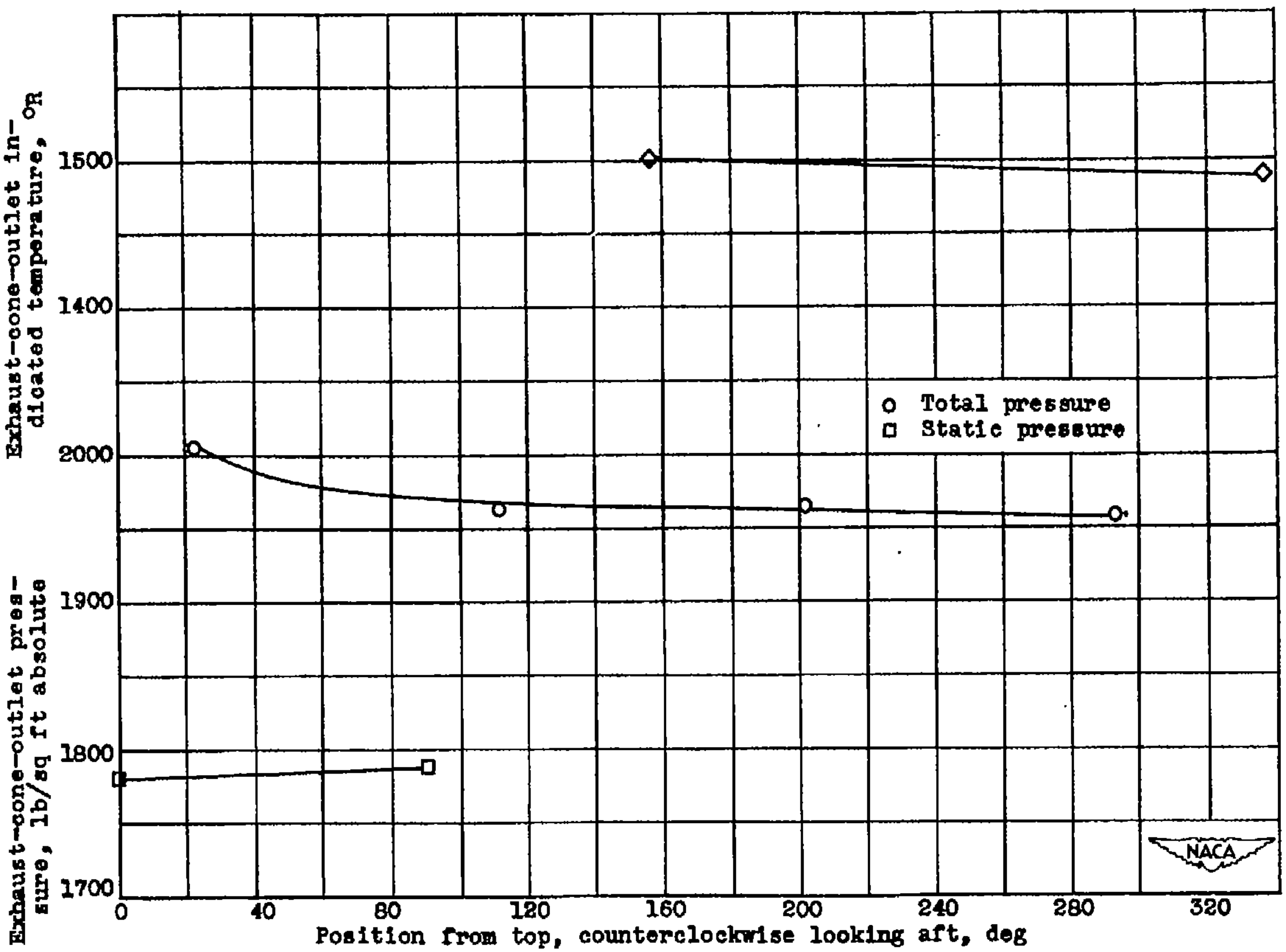
(a) Engine speed, 10,000 rpm; tail-pipe temperature, 1527° R.

Figure 12. - Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at exhaust-cone outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00



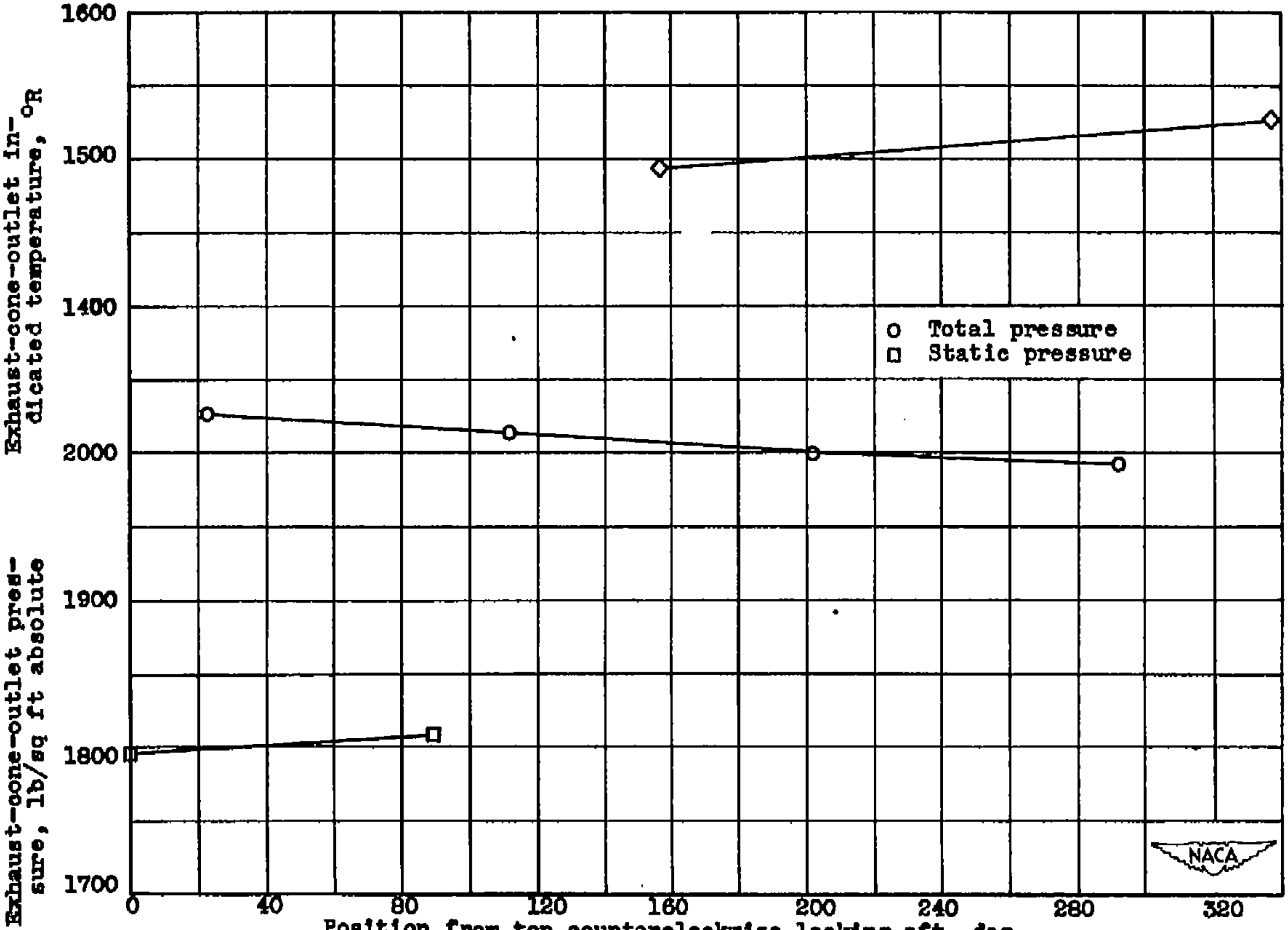
(b) Engine speed, 11,000 rpm; tail-pipe temperature, 1458° R.

Figure 12. - Continued. Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at exhaust-cone outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.



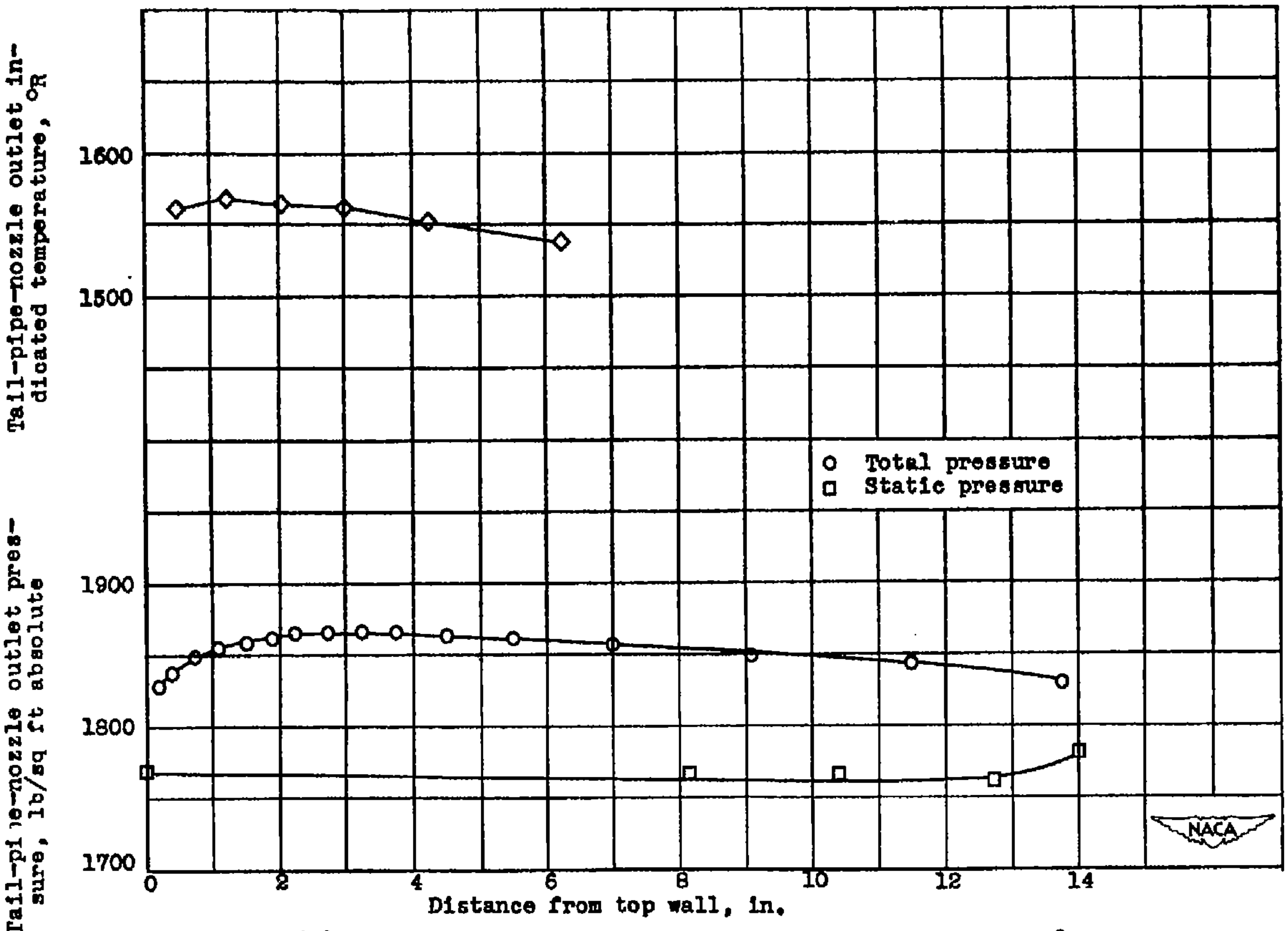
(c) Engine speed, 12,000 rpm; tail-pipe temperature, 1495° R.

Figure 12. - Continued. Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at exhaust-cone outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.



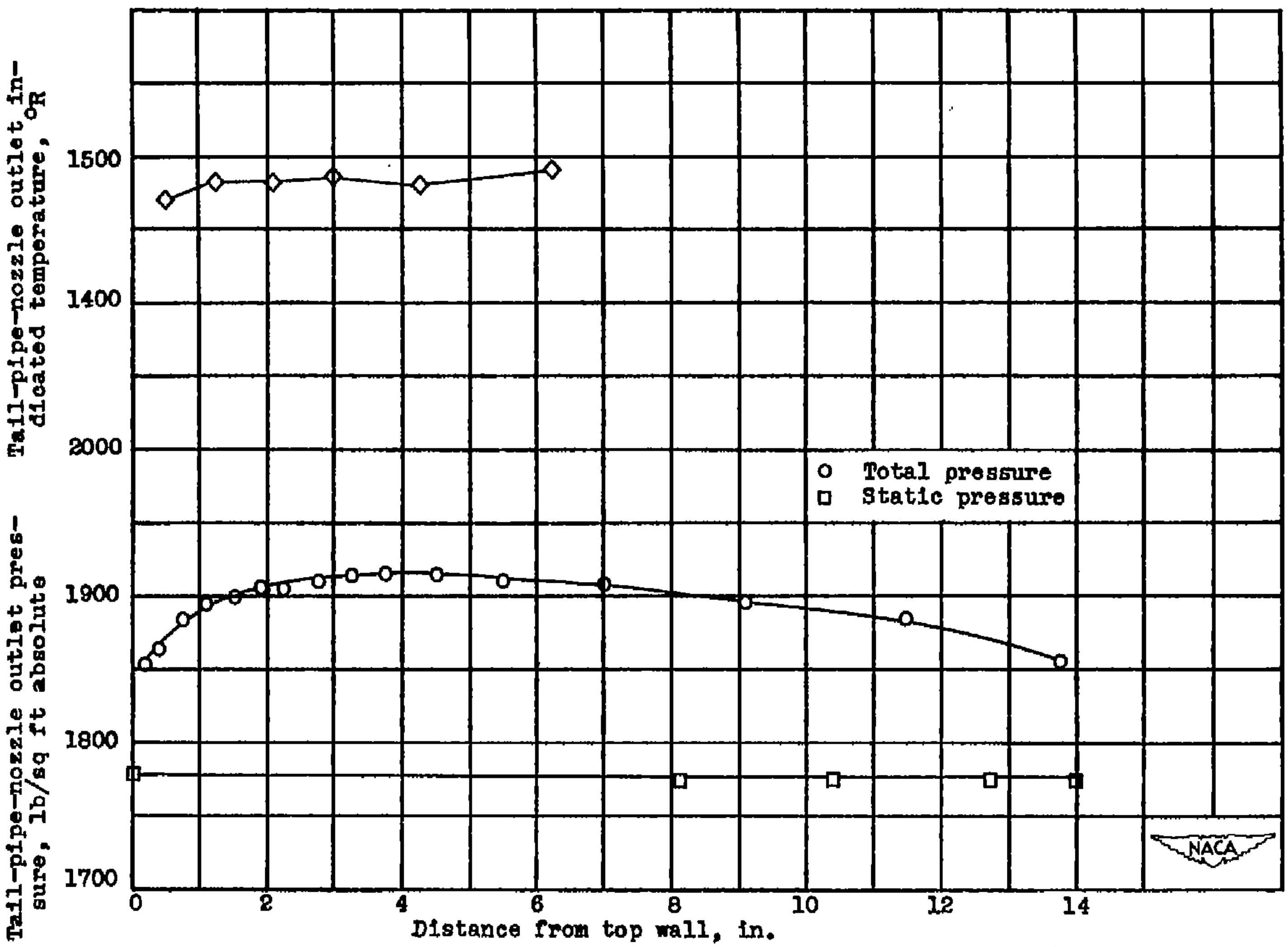
(d) Engine speed, 13,000 rpm; tail-pipe temperature, 1510° R.

Figure 12. - Concluded. Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at exhaust-cone outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.



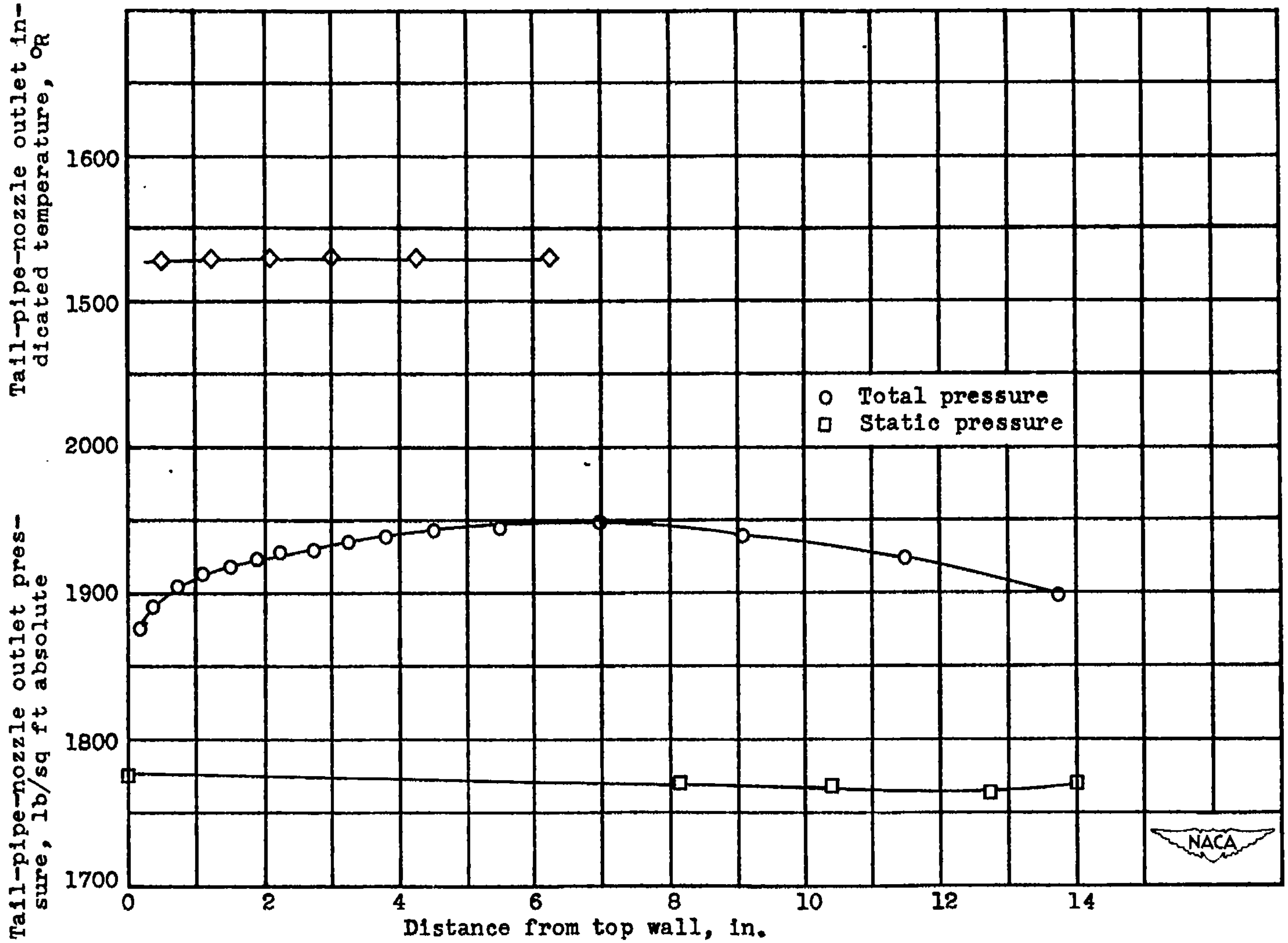
(a) Engine speed, 10,000 rpm; tail-pipe temperature, 1527° R.

Figure 13. - Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at tail-pipe-nozzle outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.



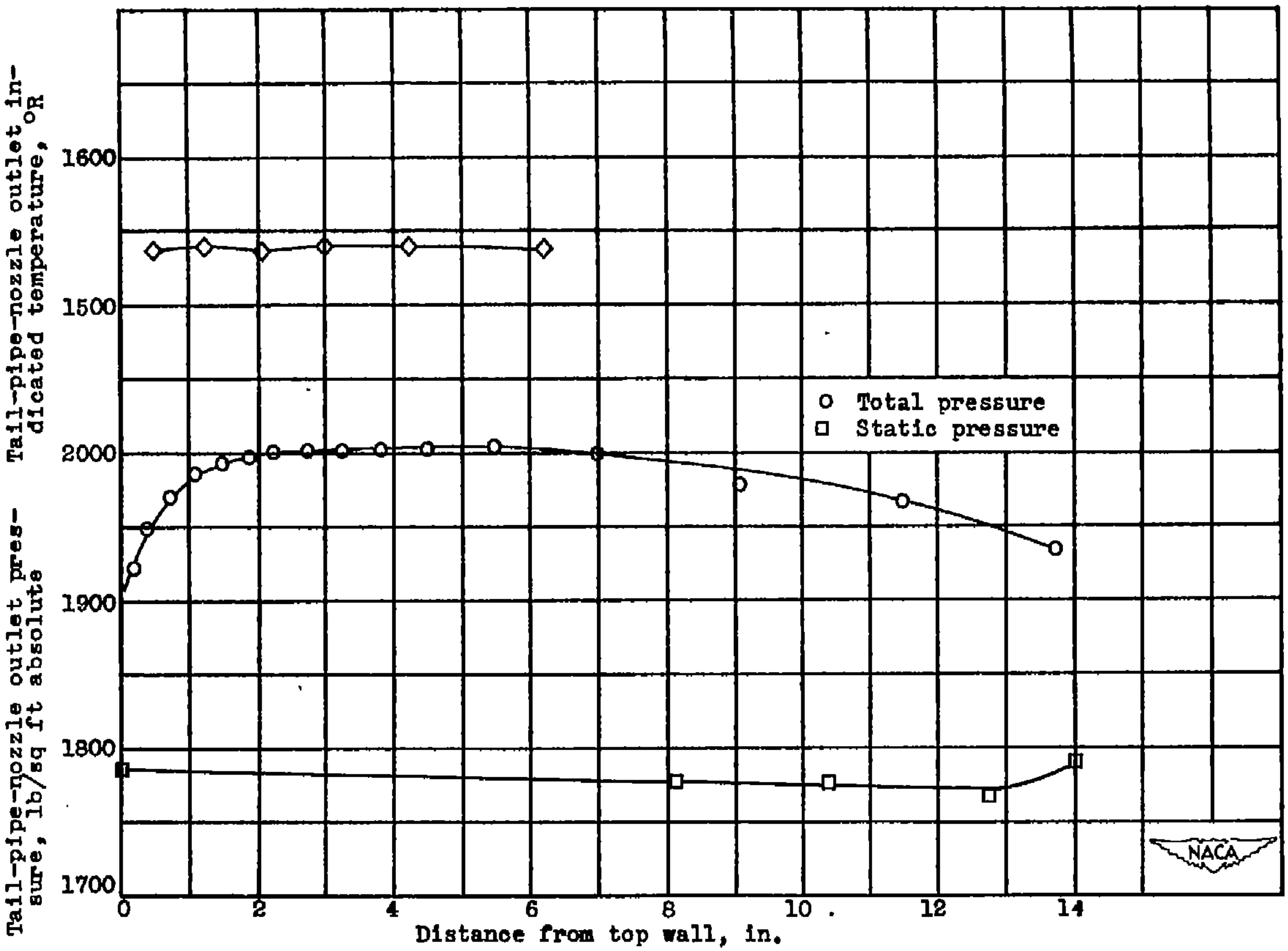
(b) Engine speed, 11,000 rpm; tail-pipe temperature, 1458° R.

Figure 13. - Continued. Effect of engine speed on distribution of total pressure, static pressure and indicated temperature at tail-pipe-nozzle outlet. Altitude, 5000 feet; compressor-inlet ram pressure ratio, 1.00.



(c) Engine speed, 12,000 rpm; tail-pipe temperature, 1495° R.

Figure 13. - Continued. Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at tail-pipe-nozzle outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.



(d) Engine speed, 13,000 rpm; tail-pipe temperature, 1510° R.

Figure 13. - Concluded. Effect of engine speed on distribution of total pressure, static pressure, and indicated temperature at tail-pipe-nozzle outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00.

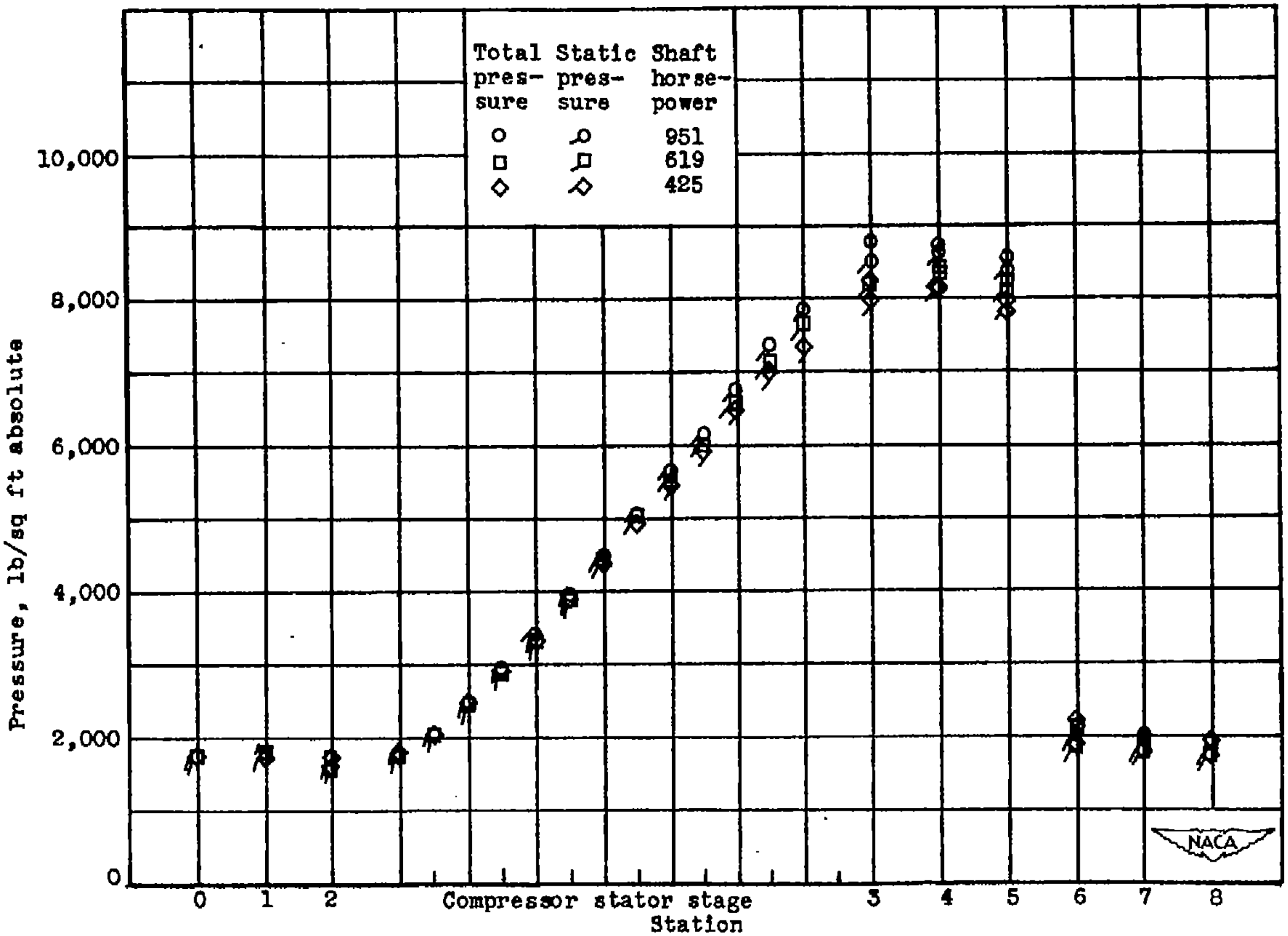
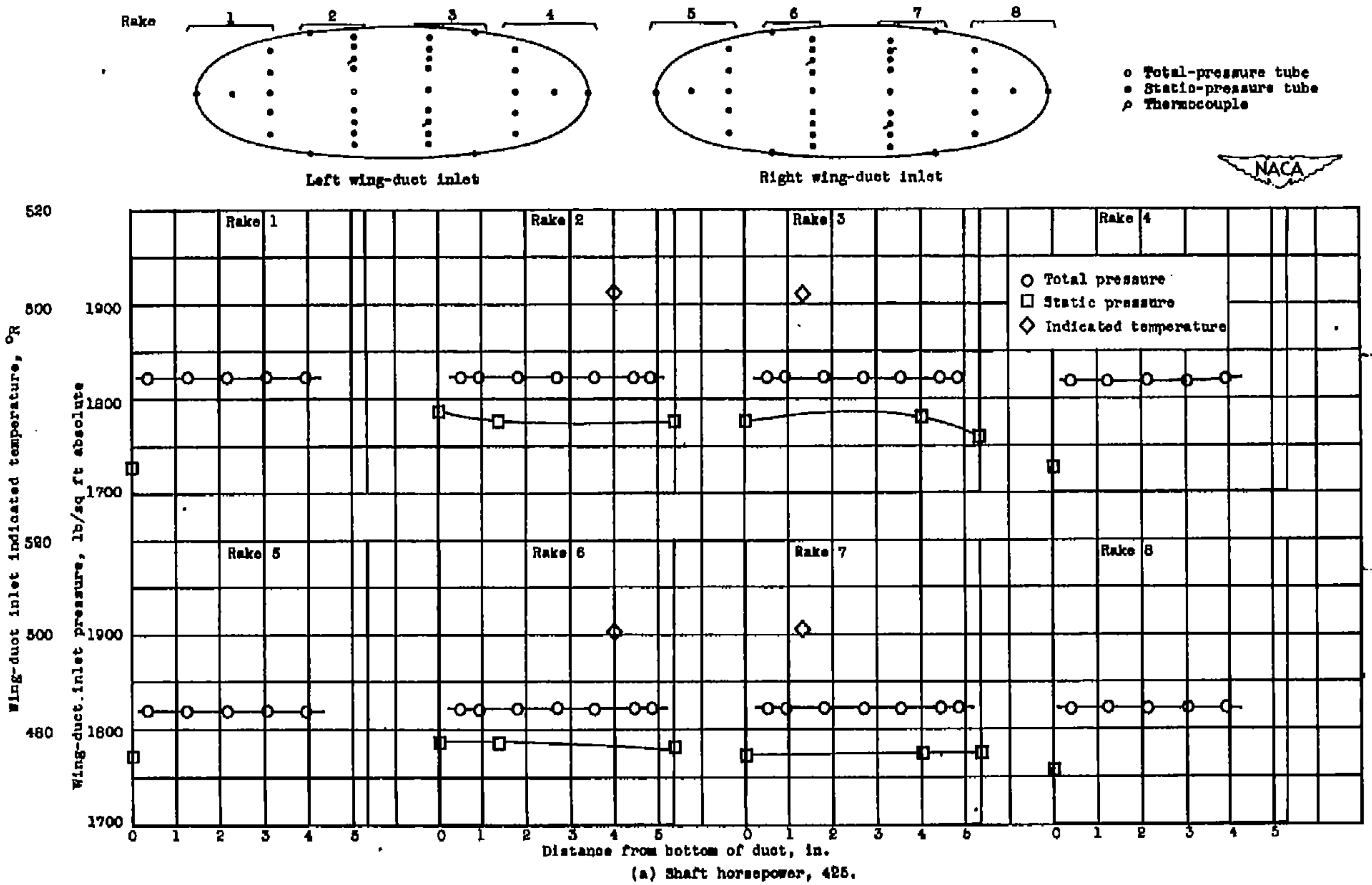
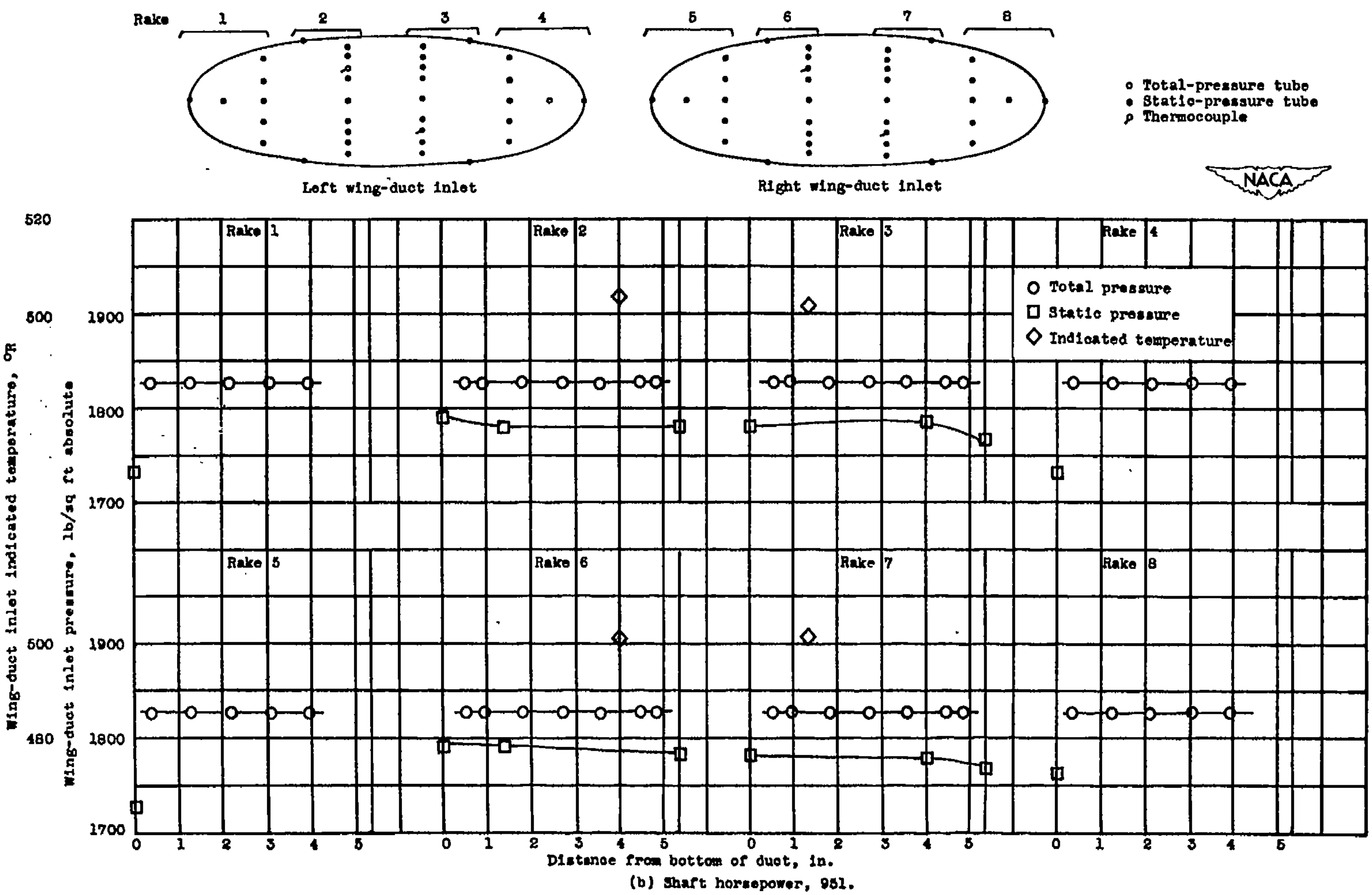


Figure 14. - Typical over-all average pressure profile for various shaft horsepowers. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.



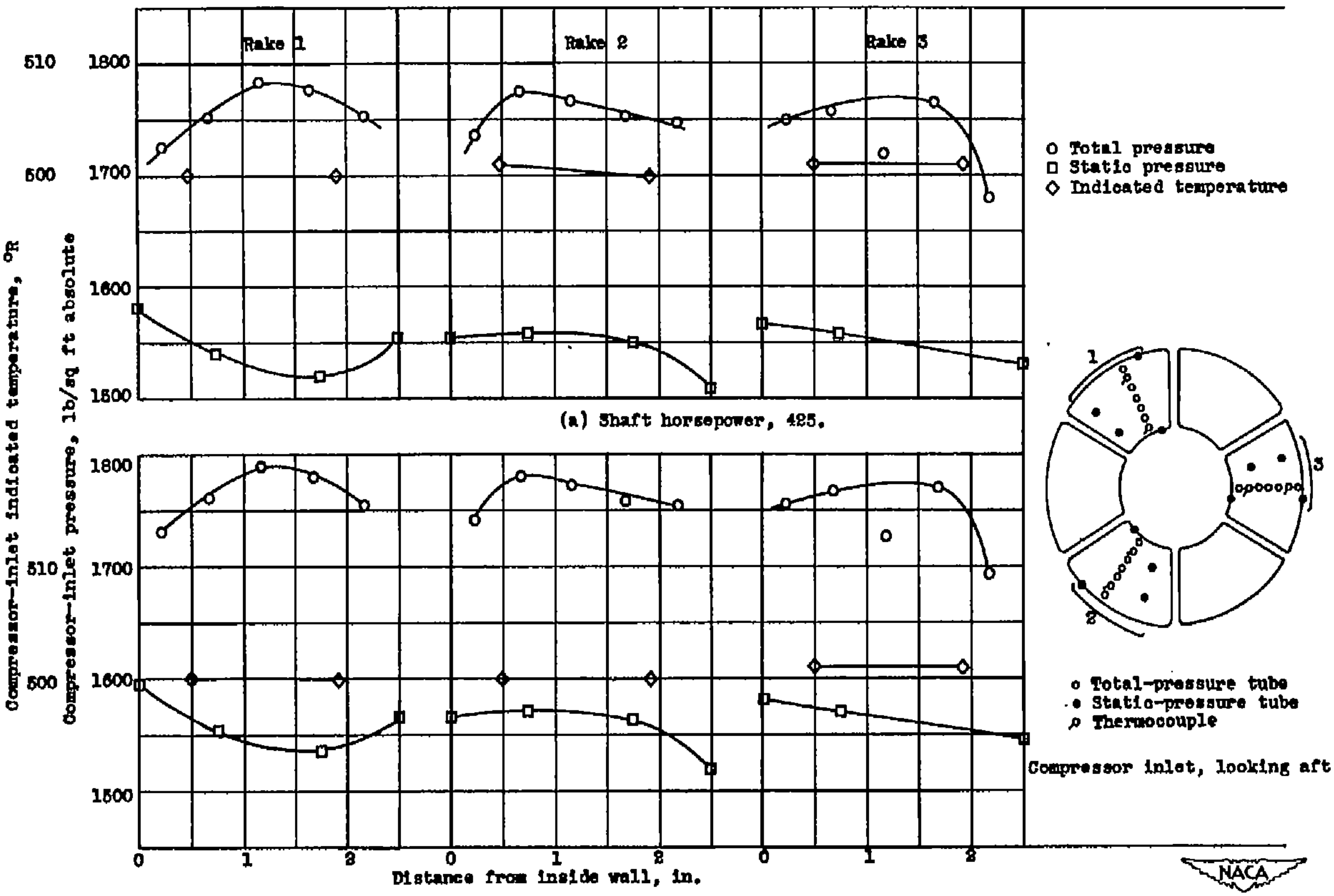
(a) Shaft horsepower, 425.

Figure 15. - Effect of shaft horsepower on distribution of total pressure, static pressure, and indicated temperature at wing-duct inlets. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.



(b) Shaft horsepower, 951.

Figure 15. - Concluded. Effect of shaft horsepower on distribution of total pressure, static pressure, and indicated temperature at wing-duct inlets. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.



(b) Shaft horsepower, 951.

Figure 16. - Effect of shaft horsepower on distribution of total pressure, static pressure, and indicated temperature at compressor inlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.

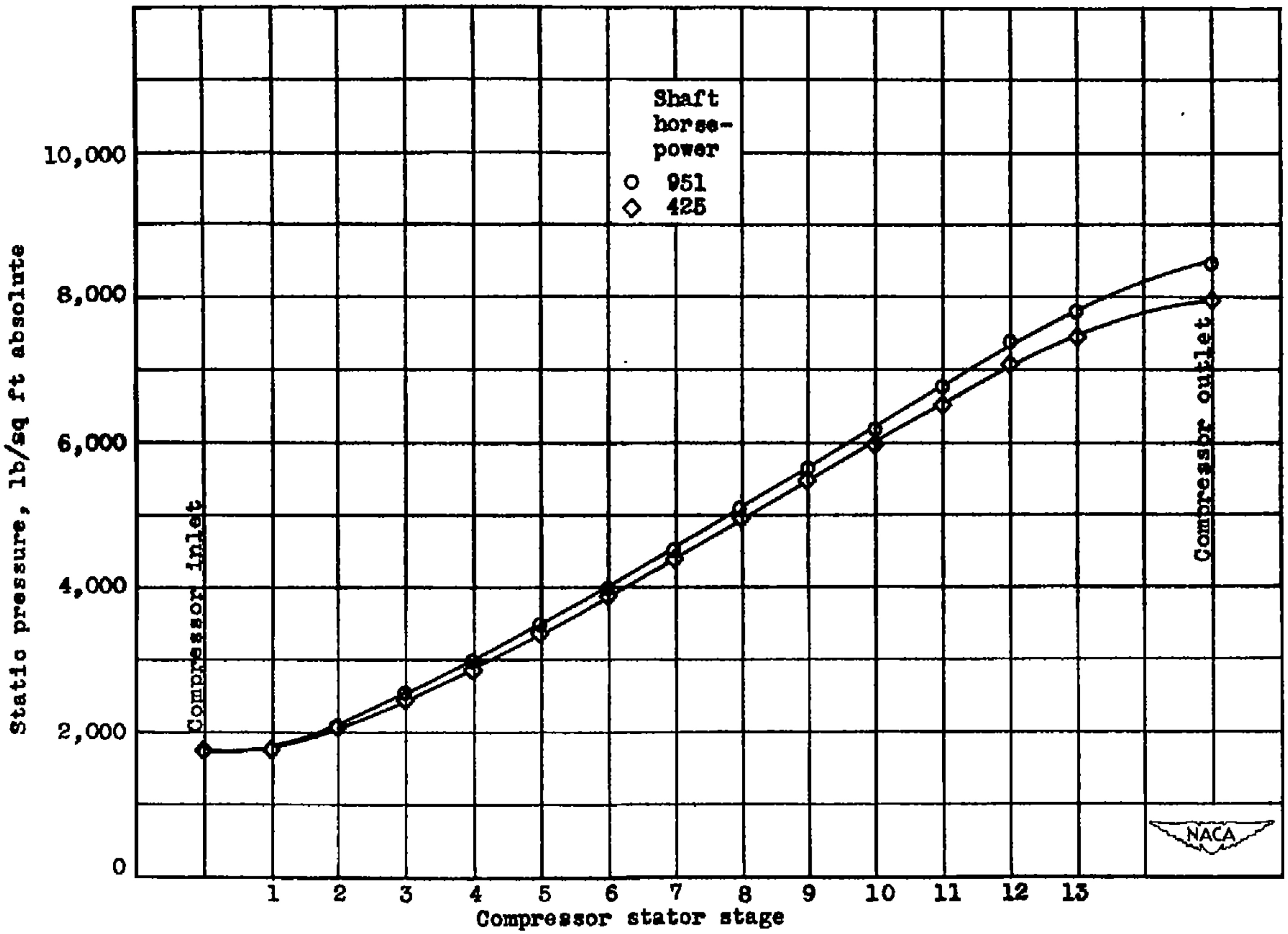


Figure 17. - Effect of shaft horsepower on distribution of static pressure for each stage of compressor stator. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.

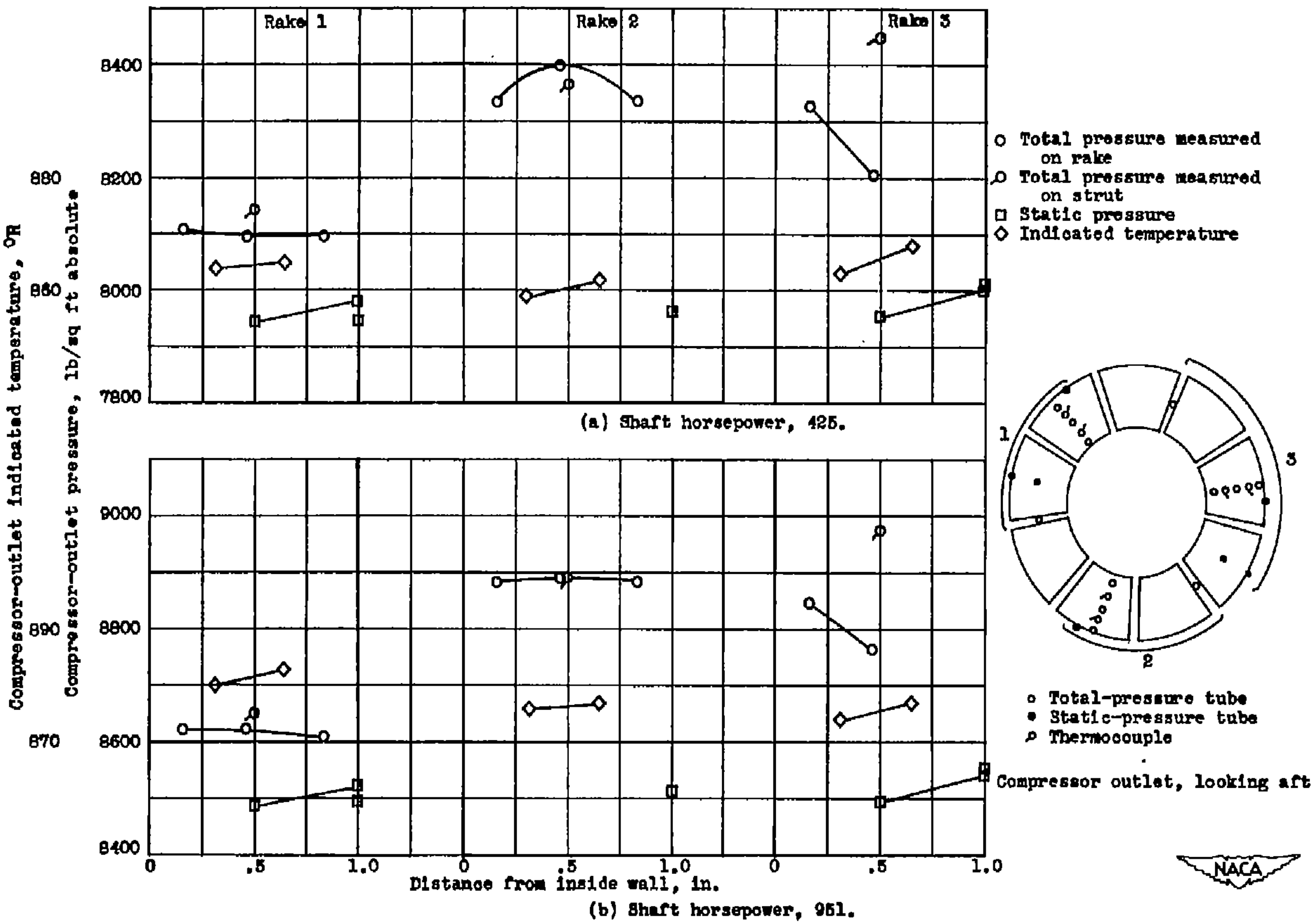
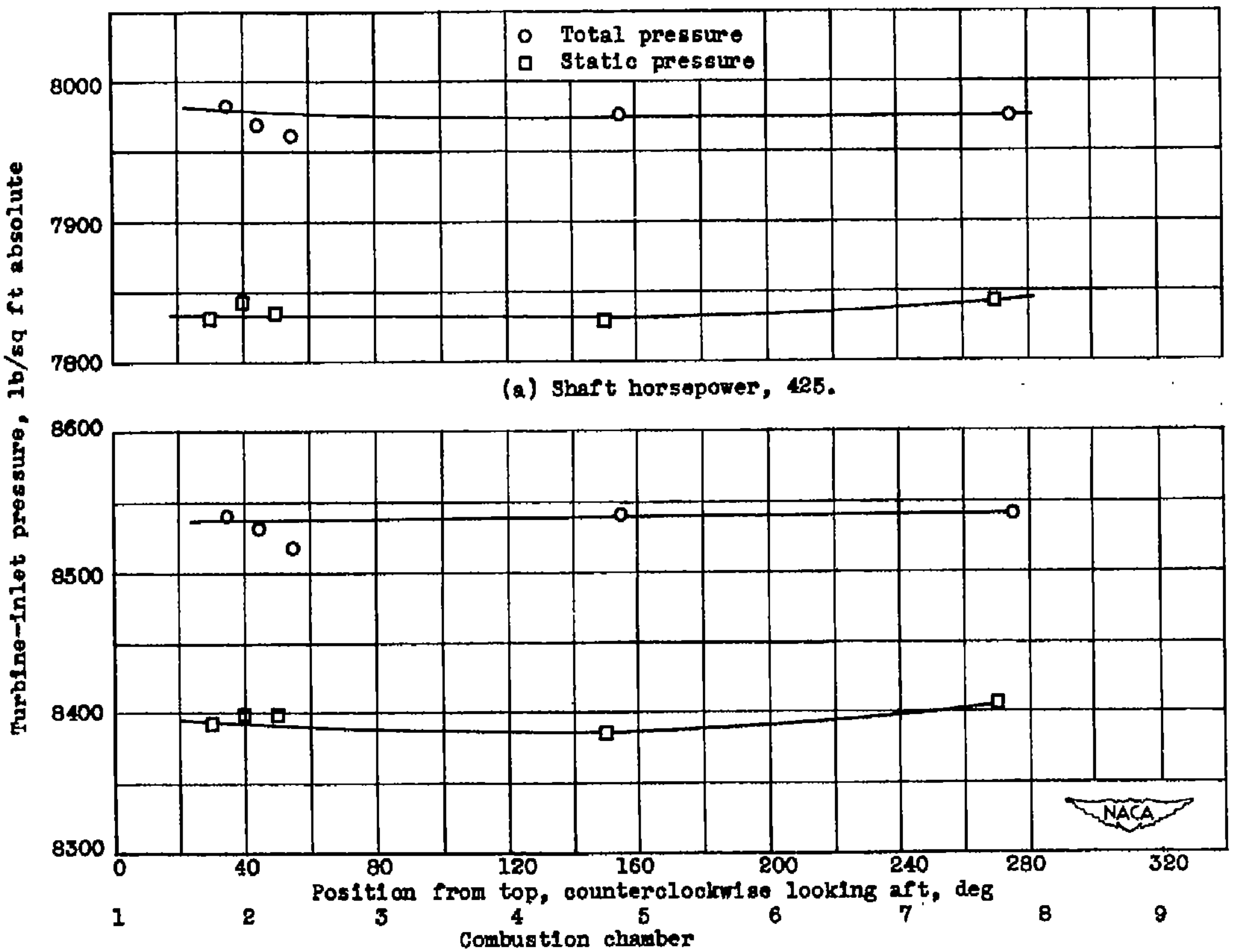
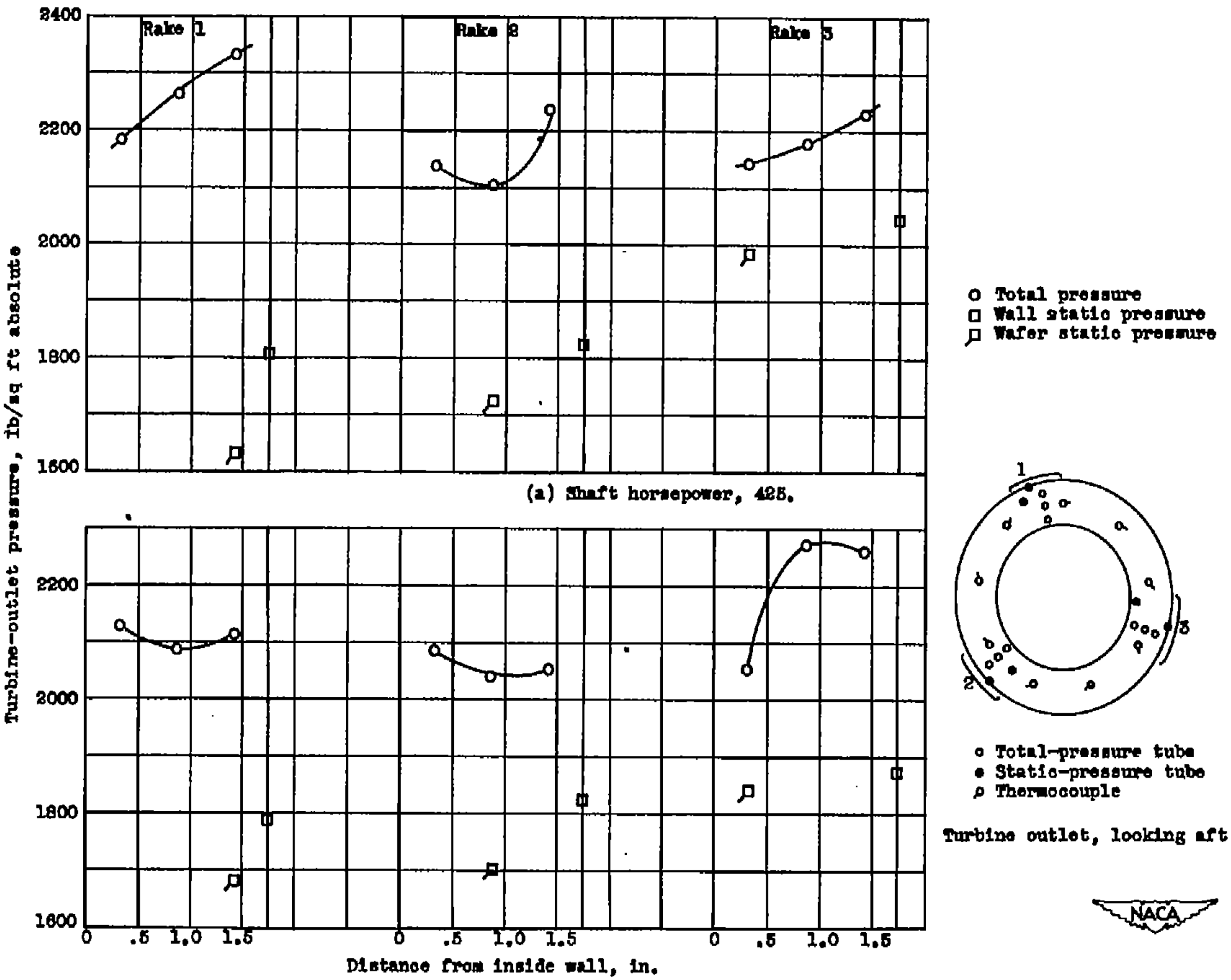


Figure 18. - Effect of shaft horsepower on distribution of total pressure, static pressure, and indicated temperature at compressor outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.



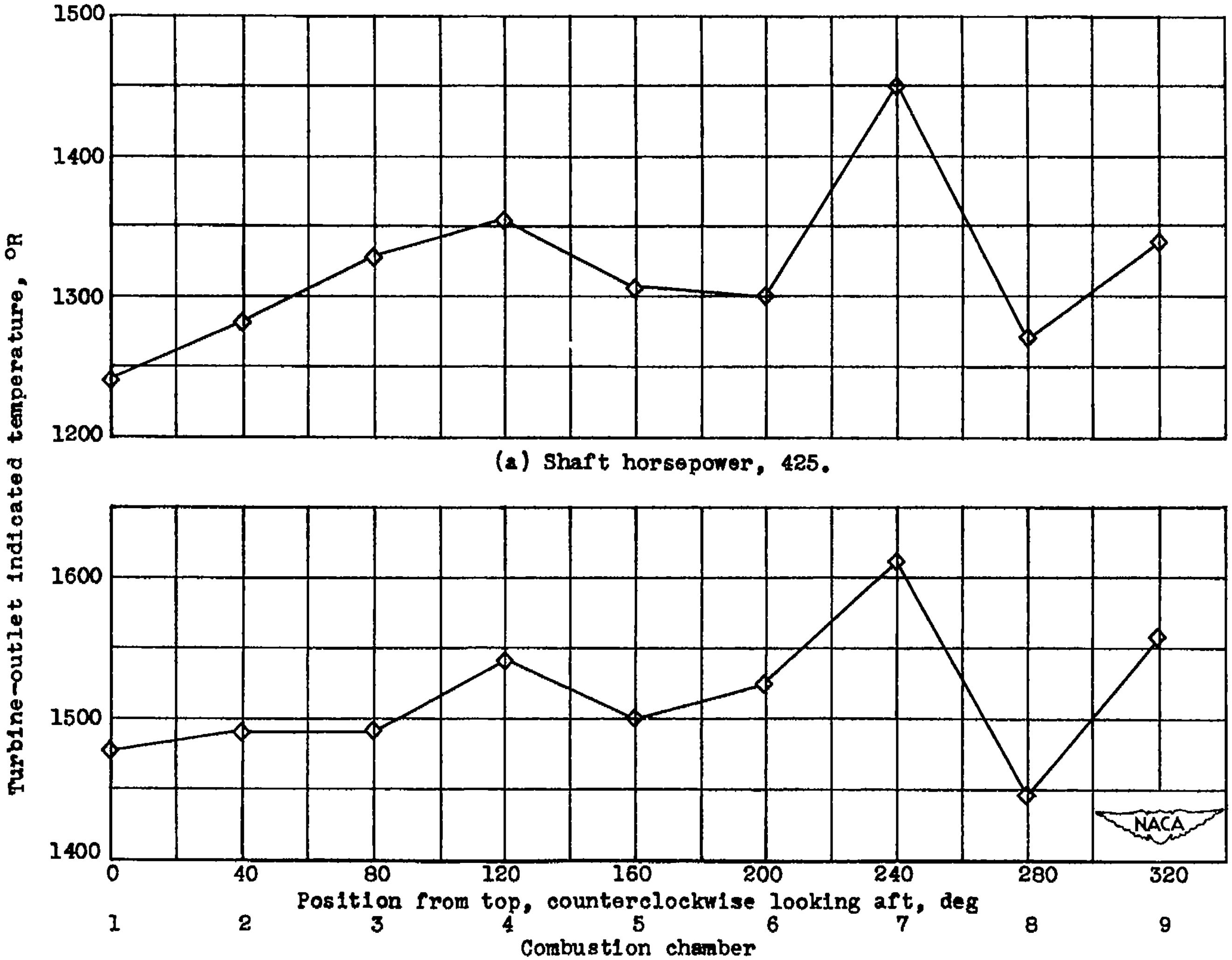
(b) Shaft horsepower, 951

Figure 19. - Effect of shaft horsepower on distribution of total and static pressures at turbine inlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.



(b) Shaft horsepower, 951.

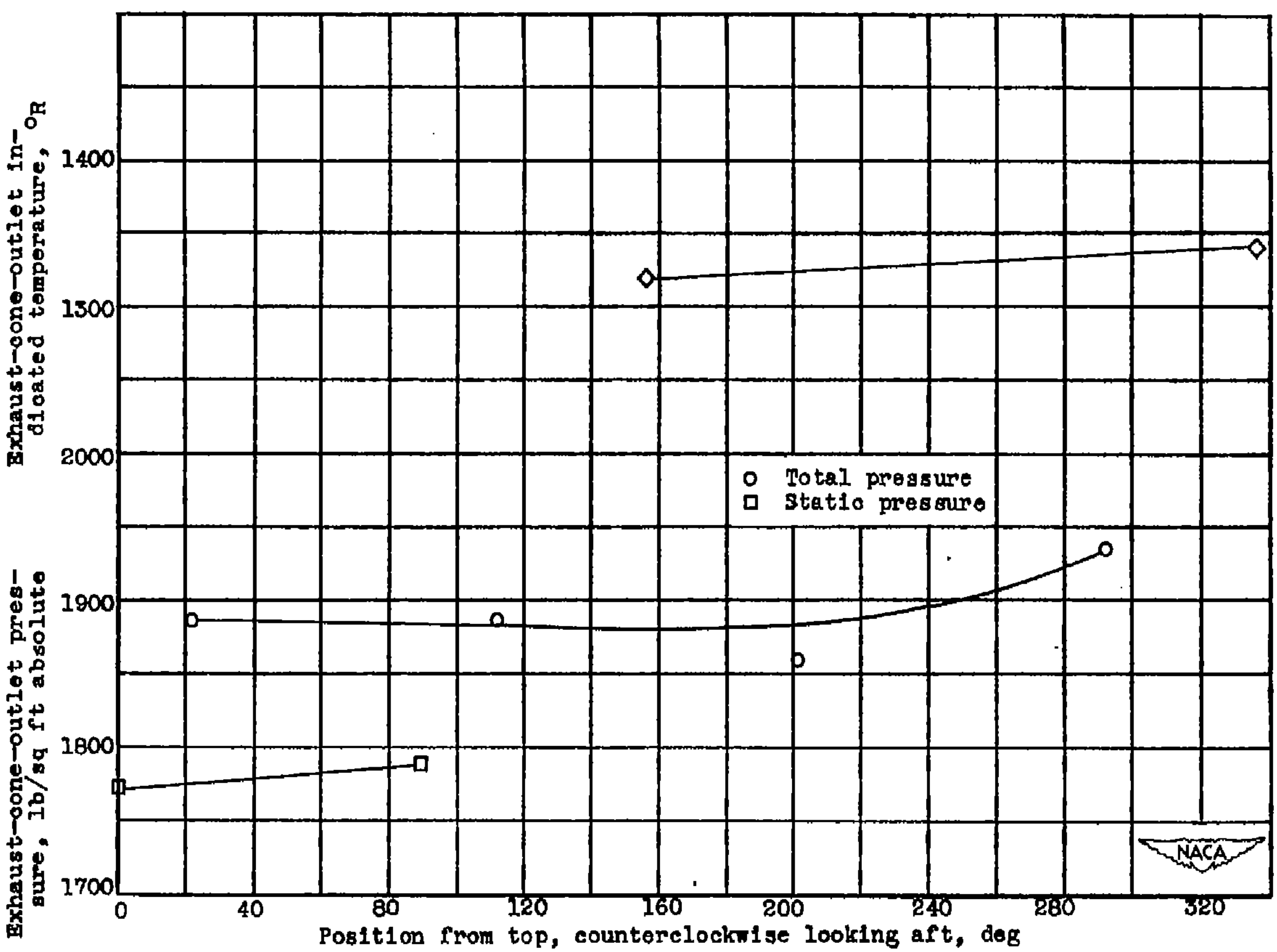
Figure 20. - Effect of shaft horsepower on distribution of total pressure and static pressure at turbine outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.



(a) Shaft horsepower, 425.

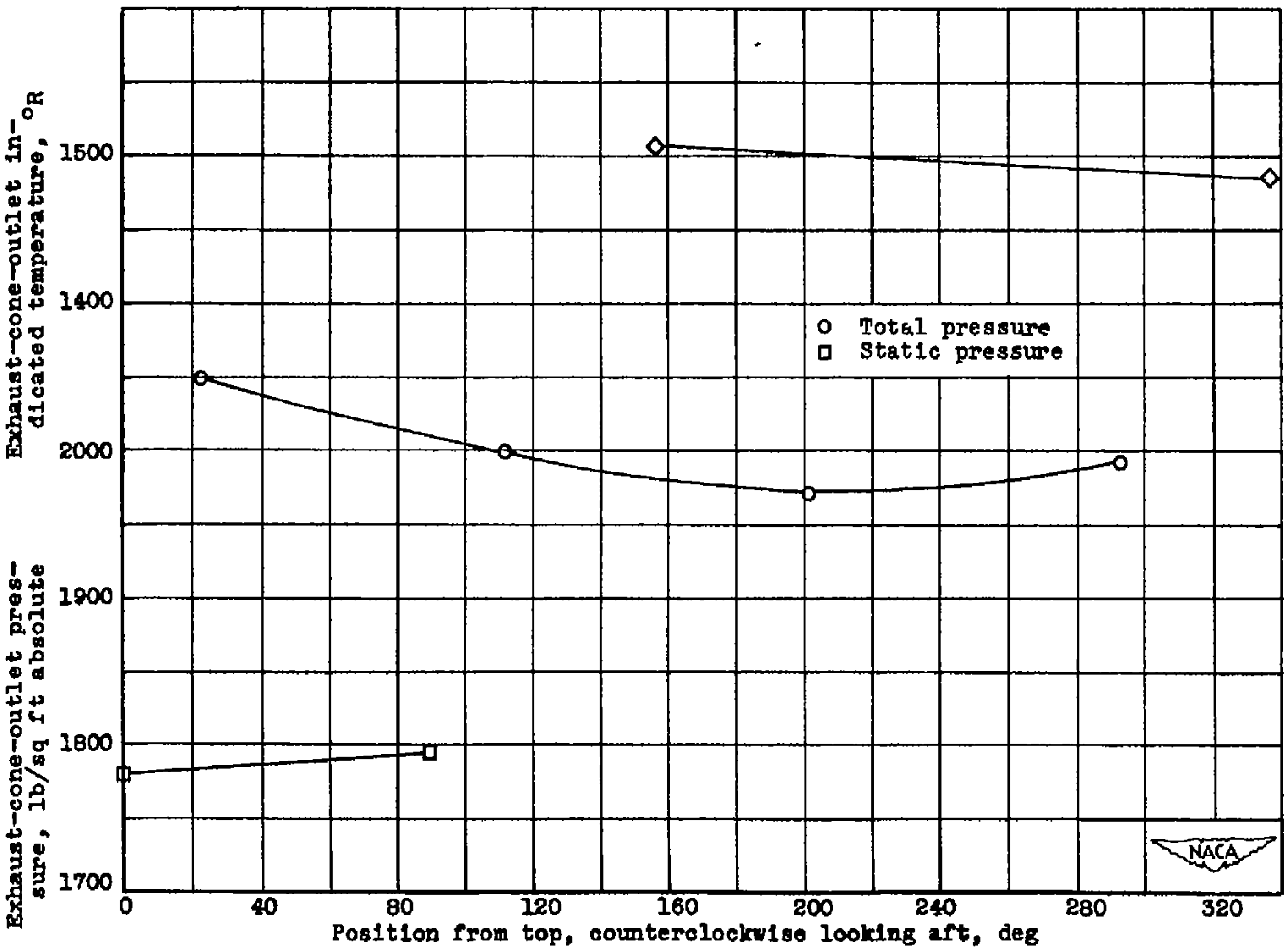
(b) Shaft horsepower, 951.

Figure 21. - Effect of shaft horsepower on distribution of indicated temperature at turbine outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.



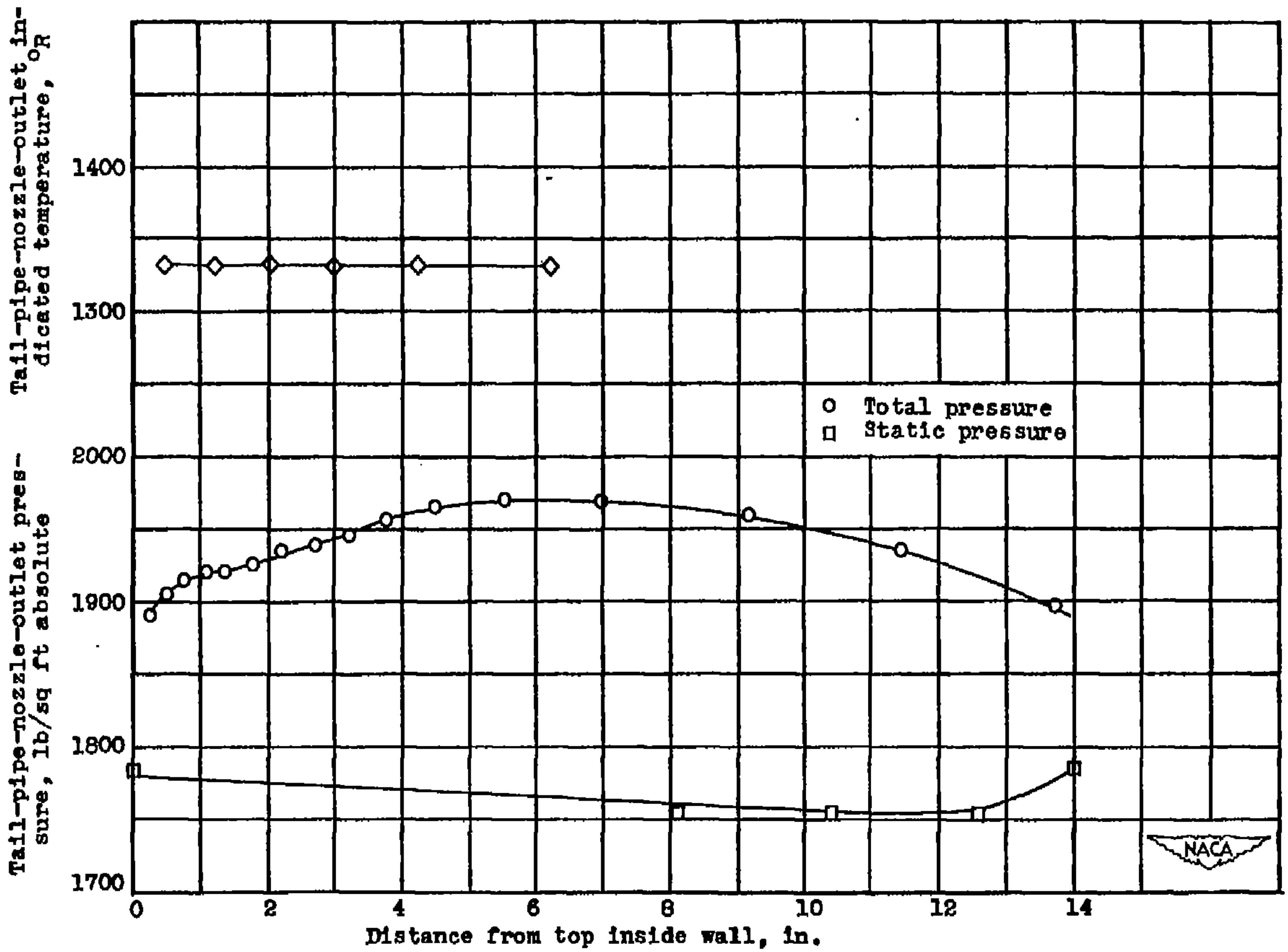
(a) Shaft horsepower, 425.

Figure 22. - Effect of shaft horsepower on distribution of total pressure, static pressure, and indicated temperature at exhaust-cone outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.



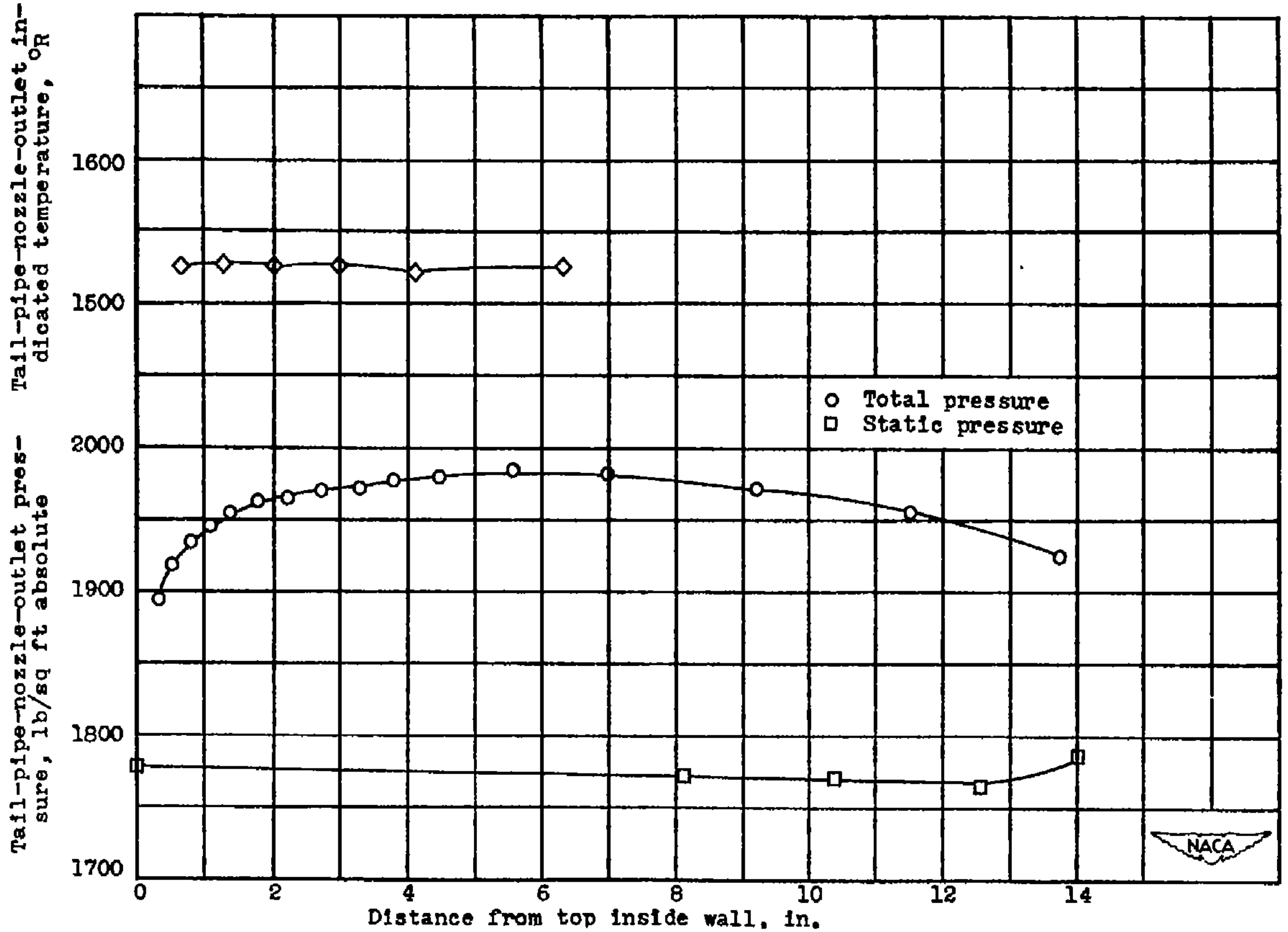
(b) Shaft horsepower, 951.

Figure 22. - Concluded. Effect of shaft horsepower on distribution of total pressure, static pressure, and indicated temperature at exhaust-cone outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.



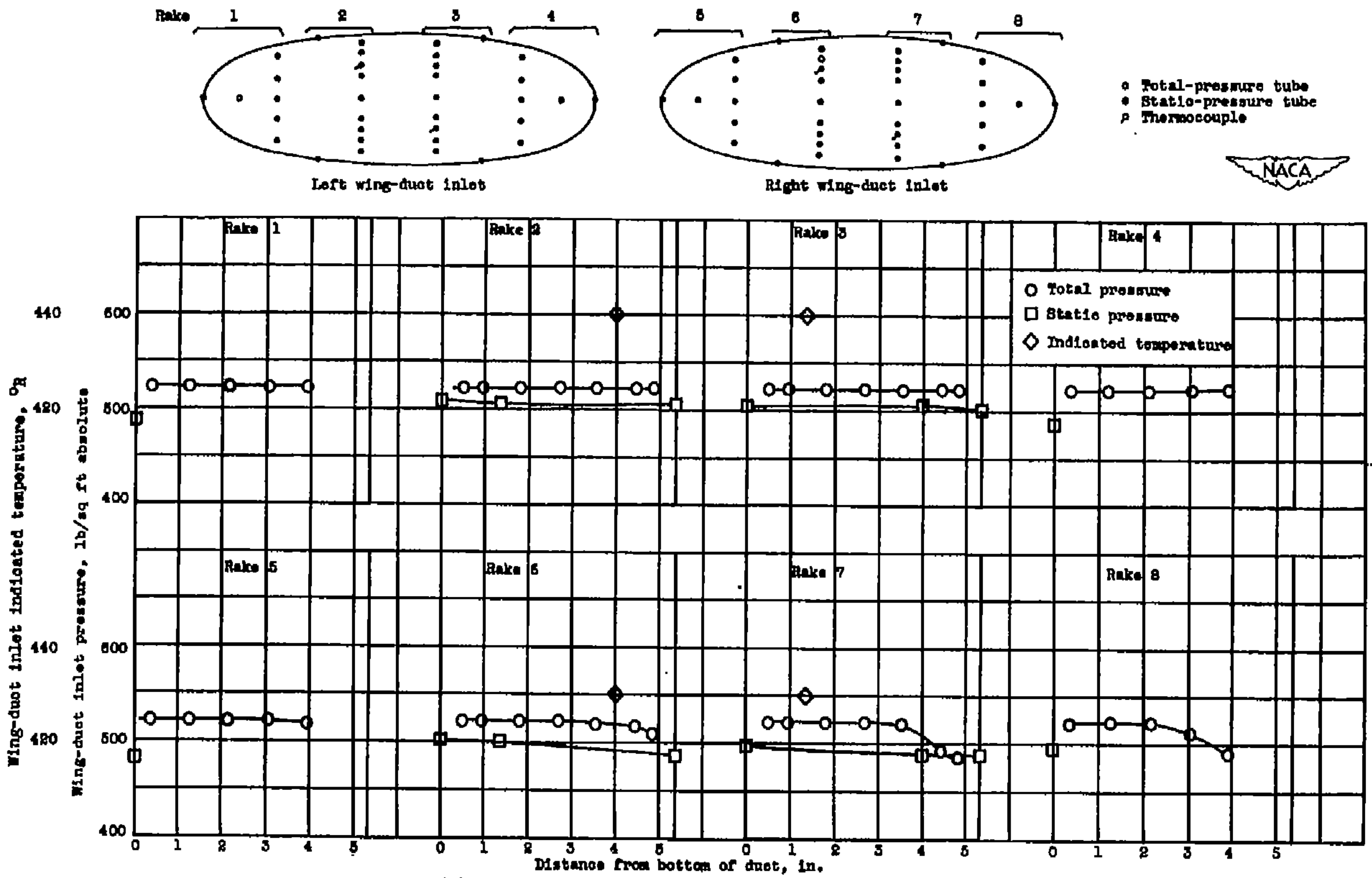
(a) Shaft horsepower, 425.

Figure 23. - Effect of shaft horsepower on distribution of total pressure, static pressure, and indicated temperature at tail-pipe-nozzle outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.



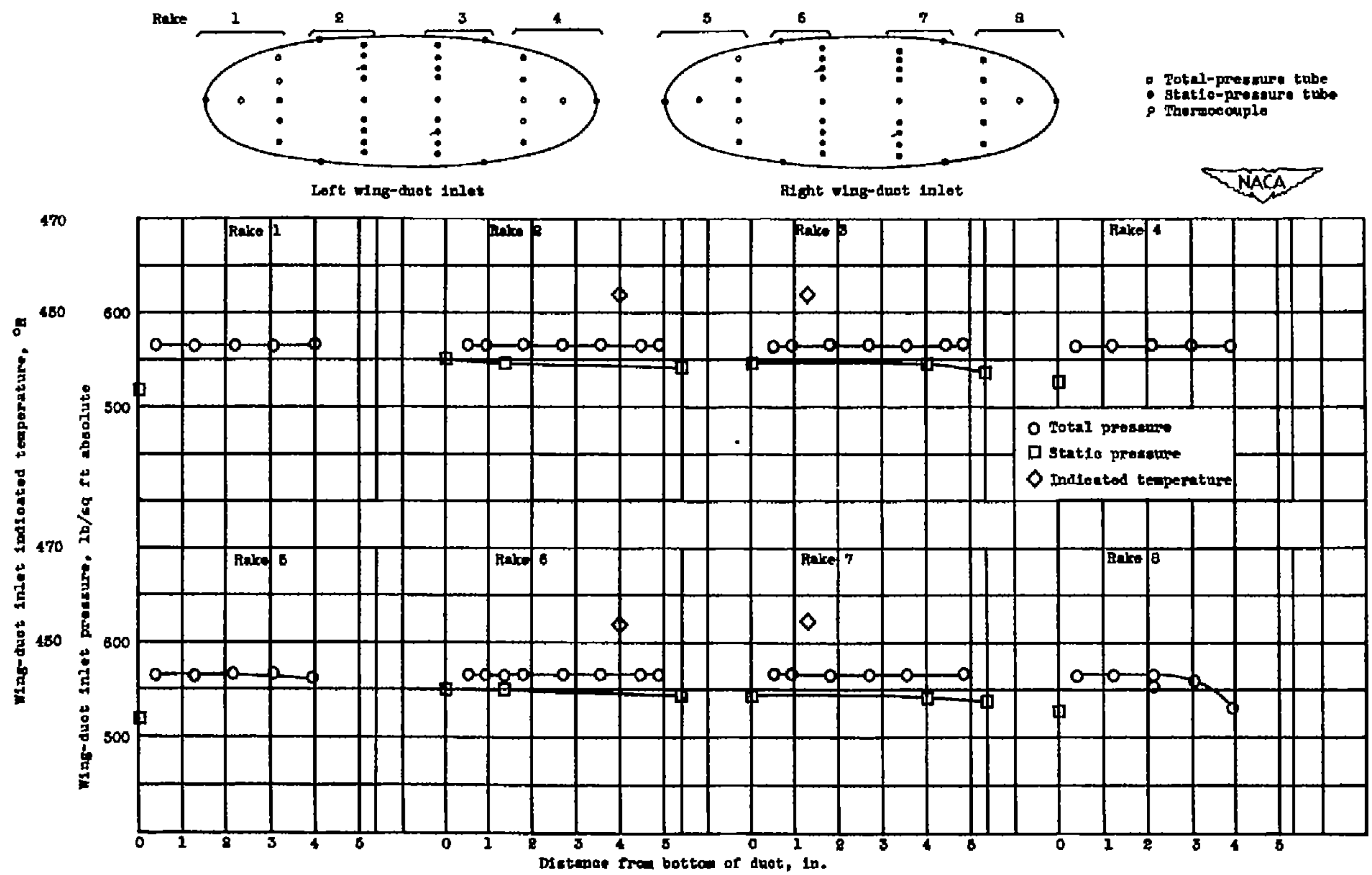
(b) Shaft horsepower, 951.

Figure 23. - Concluded. Effect of shaft horsepower on distribution of total pressure, static pressure, and indicated temperature at tail-pipe-nozzle outlet. Altitude, 5000 feet; compressor-inlet ram-pressure ratio, 1.00; engine speed, 13,000 rpm.



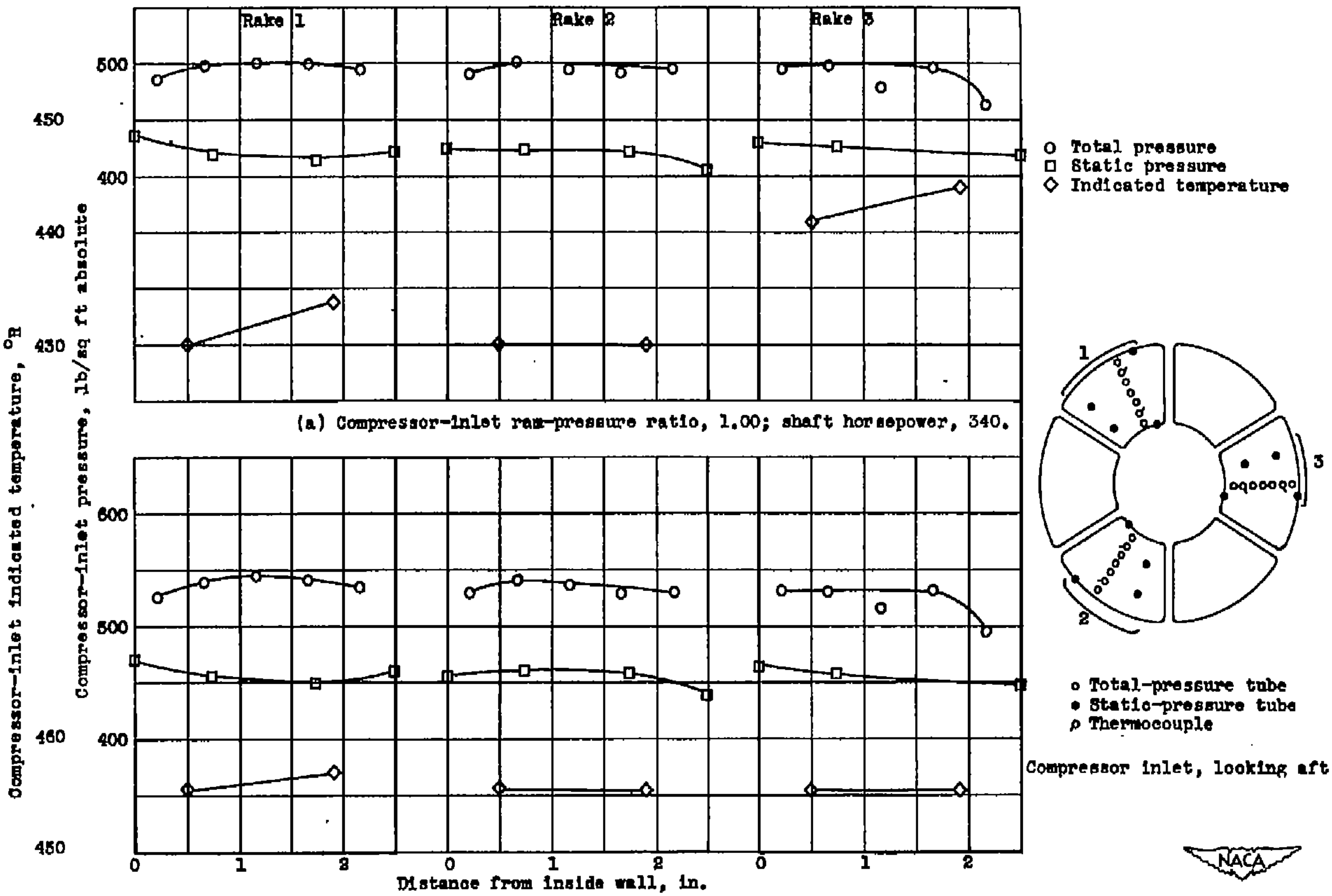
(a) Compressor-inlet ram-pressure ratio, 1.00; shaft horsepower, 340.

Figure 24. - Effect of compressor-inlet ram-pressure ratio on distribution of total pressure, static pressure, and indicated temperature at wing-duct inlets. Altitude, 35,000 feet; engine speed, 13,000 rpm.



(b) Compressor-inlet ram-pressure ratio, 1.09; shaft horsepower, 330.

Figure 24. - Concluded. Effect of compressor-inlet ram-pressure ratio on distribution of total pressure, static pressure, and indicated temperature at wing-duct inlets. Altitude, 35,000 feet; engine speed, 13,000 rpm.



(b) Compressor-inlet ram-pressure ratio, 1.09; shaft horsepower, 330.

Figure 25. - Effect of compressor-inlet ram-pressure ratio on distribution of total pressure, static pressure, and indicated temperature at compressor inlet. Altitude, 35,000 feet; engine speed, 13,000 rpm.

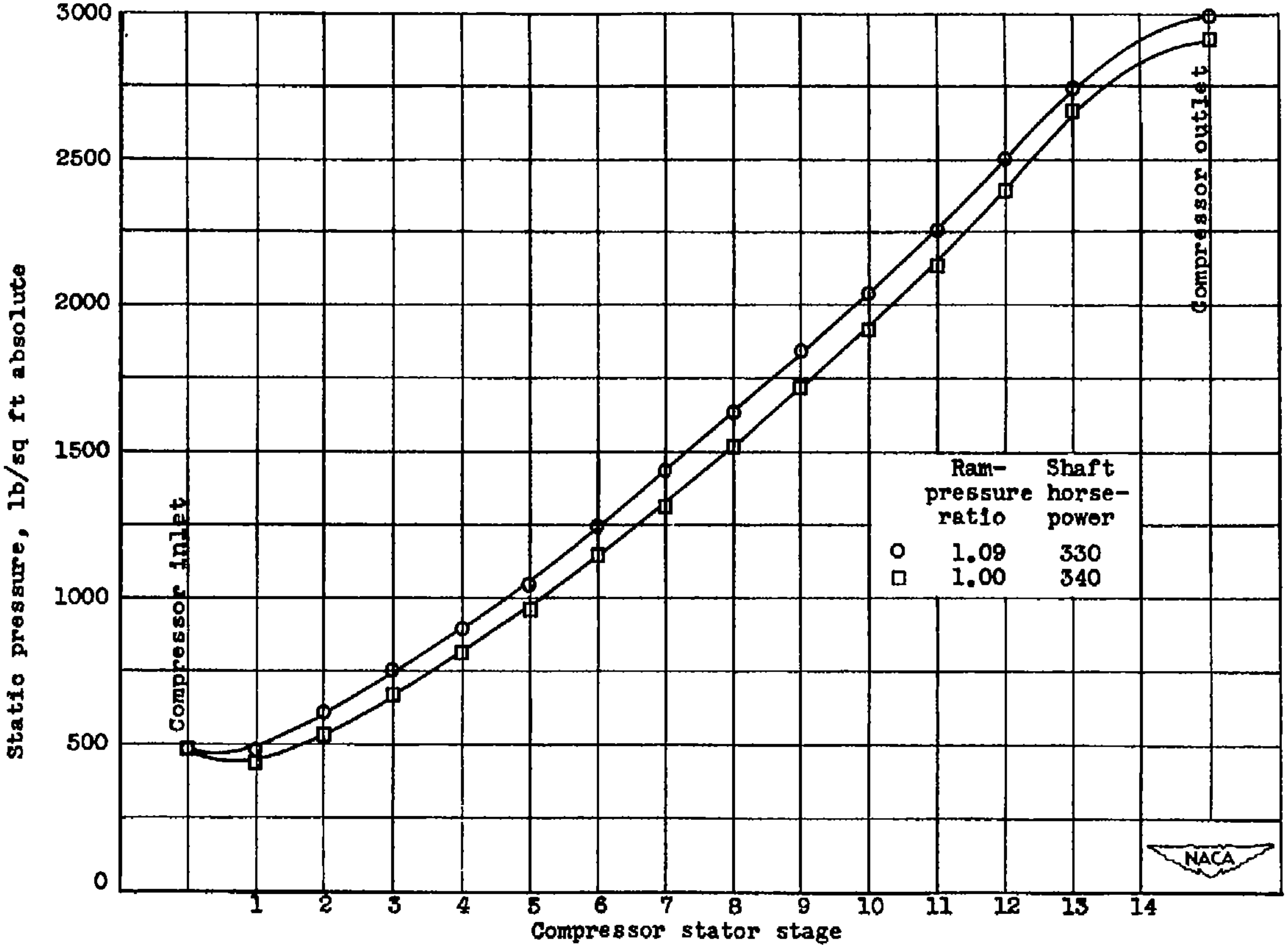


Figure 26. - Effect of compressor-inlet ram-pressure ratio on distribution of static pressure for each stage of compressor stator. Altitude, 35,000 feet; engine speed, 13,000 rpm.

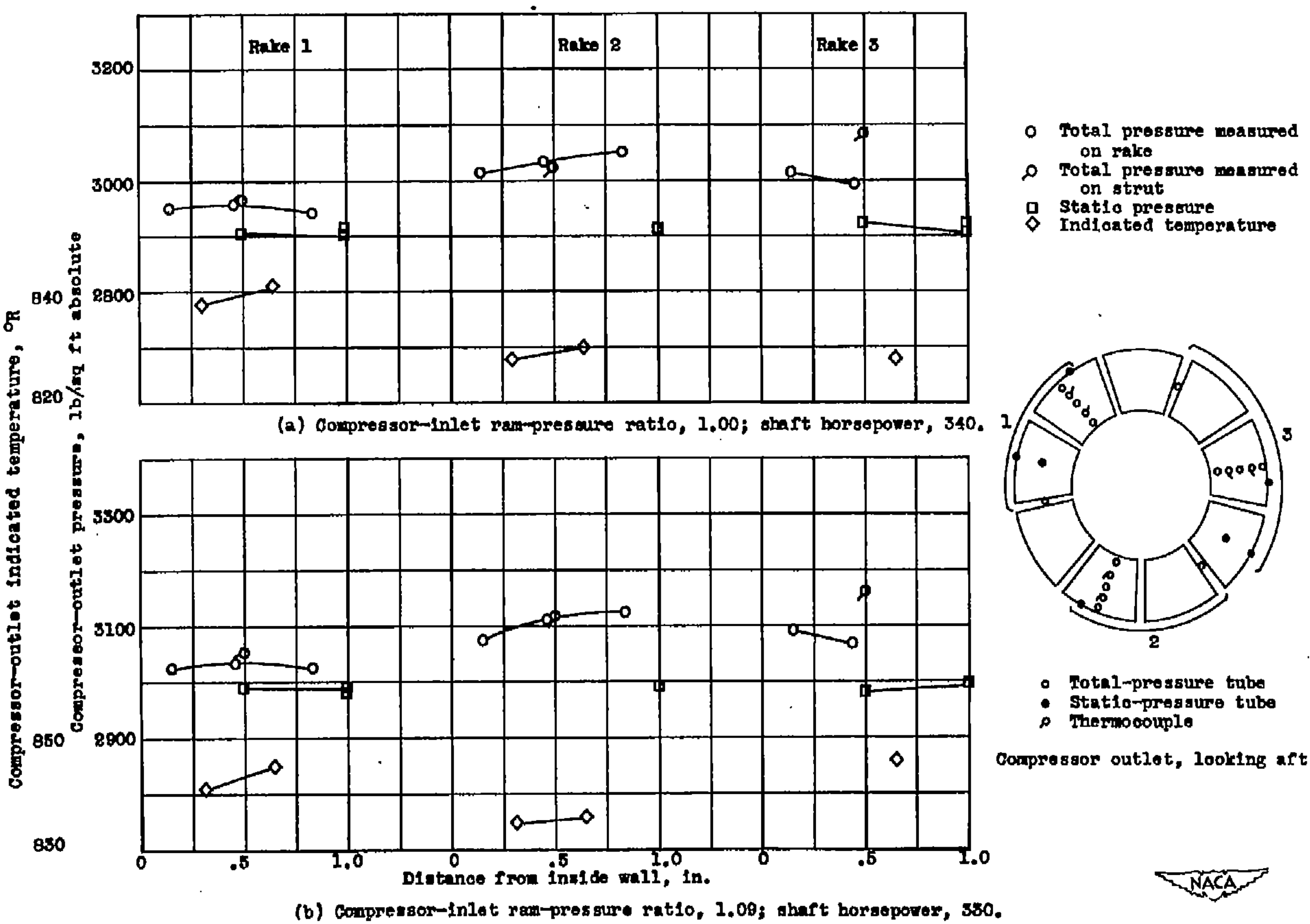
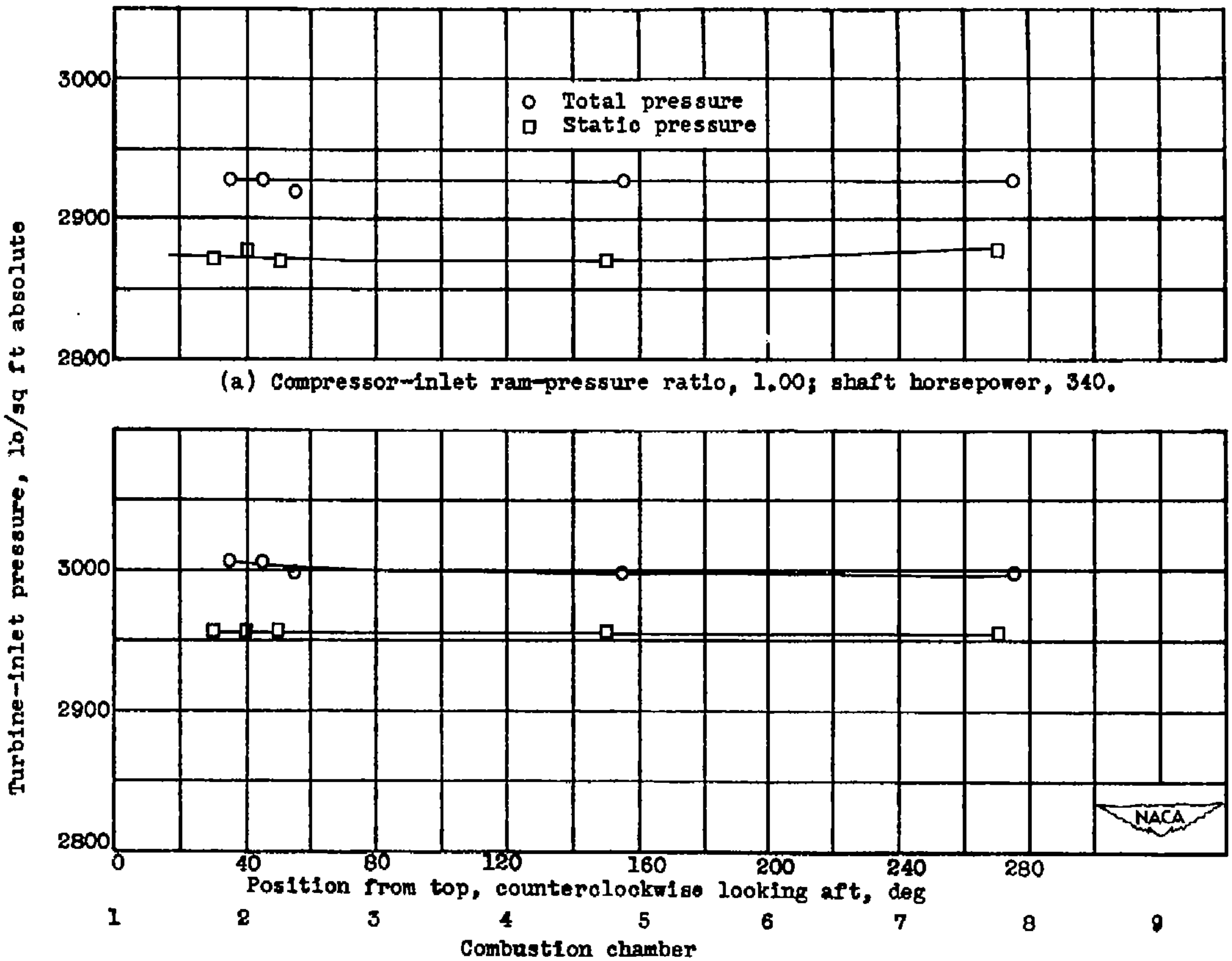


Figure 27. - Effect of compressor-inlet ram-pressure ratio on distribution of total pressure, static pressure, and indicated temperature at compressor outlet. Altitude, 35,000 feet; engine speed, 13,000 rpm.



(b) Compressor-inlet ram-pressure ratio, 1.09; shaft horsepower, 330.

Figure 28. - Effect of compressor-inlet ram-pressure ratio on distribution of total and static pressures at turbine inlet. Altitude, 35,000 feet; engine speed, 13,000 rpm.

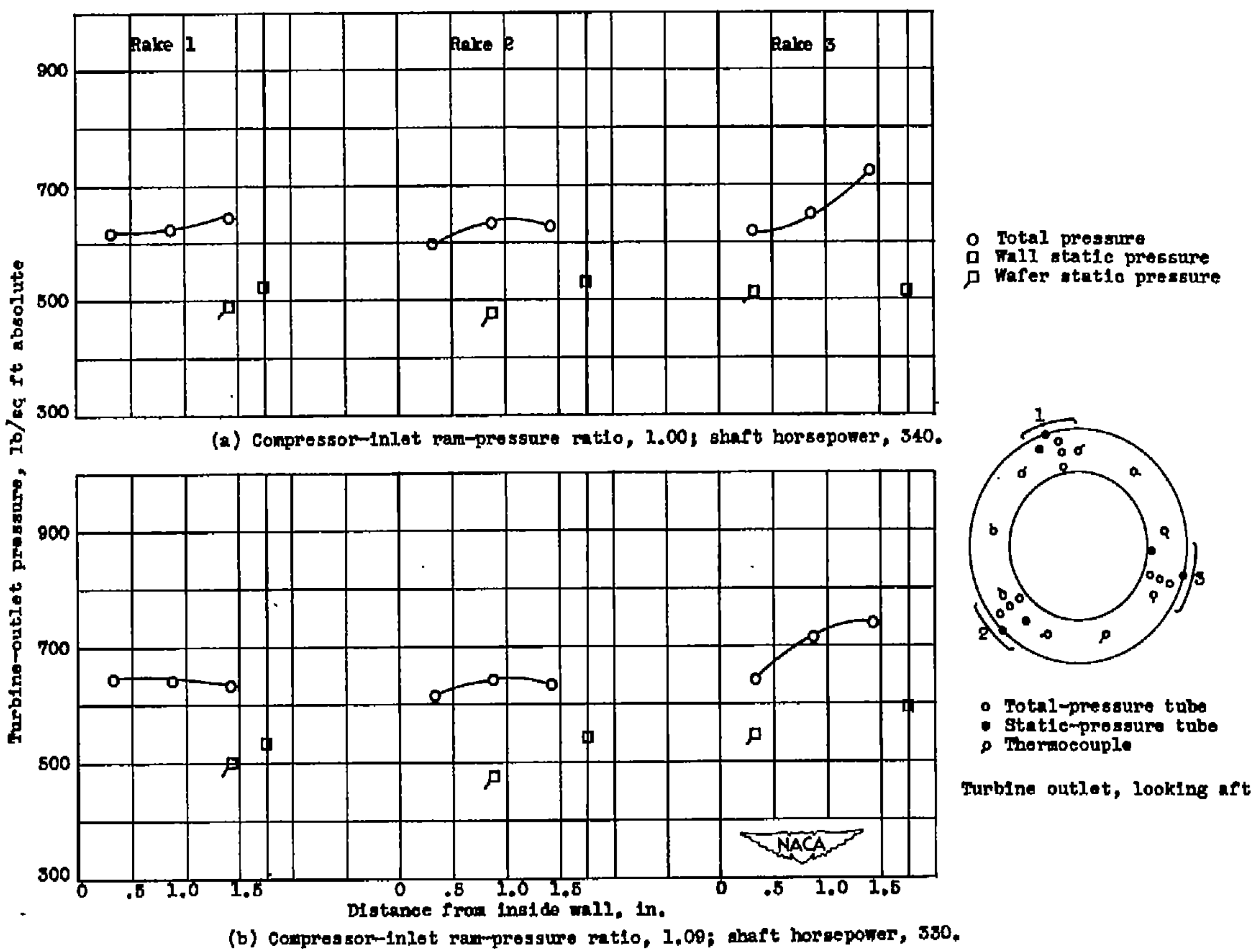
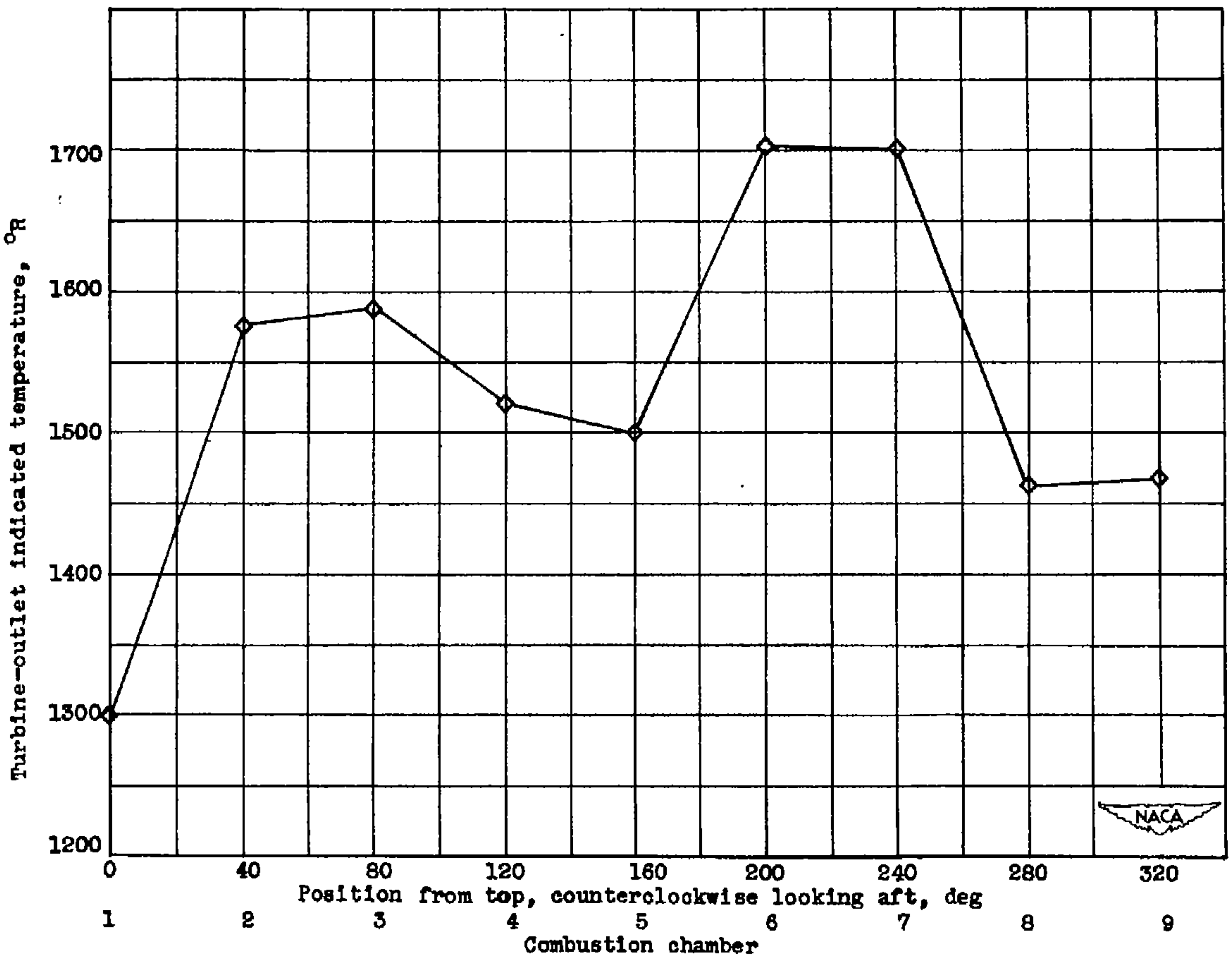
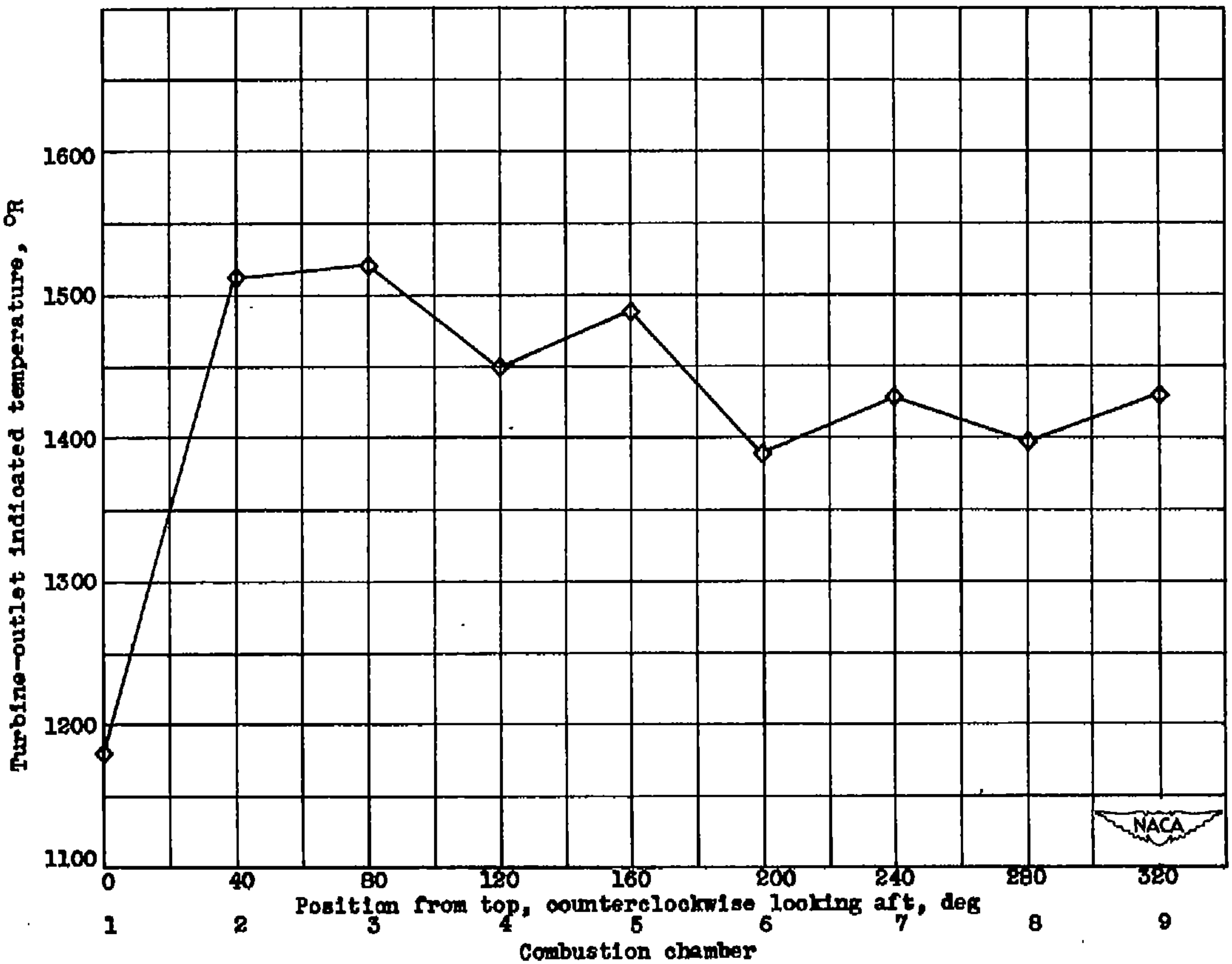


Figure 29. - Effect of compressor-inlet ram-pressure ratio on distribution of total and static pressure at turbine outlet. Altitude, 35,000 feet; engine speed, 13,000 rpm.



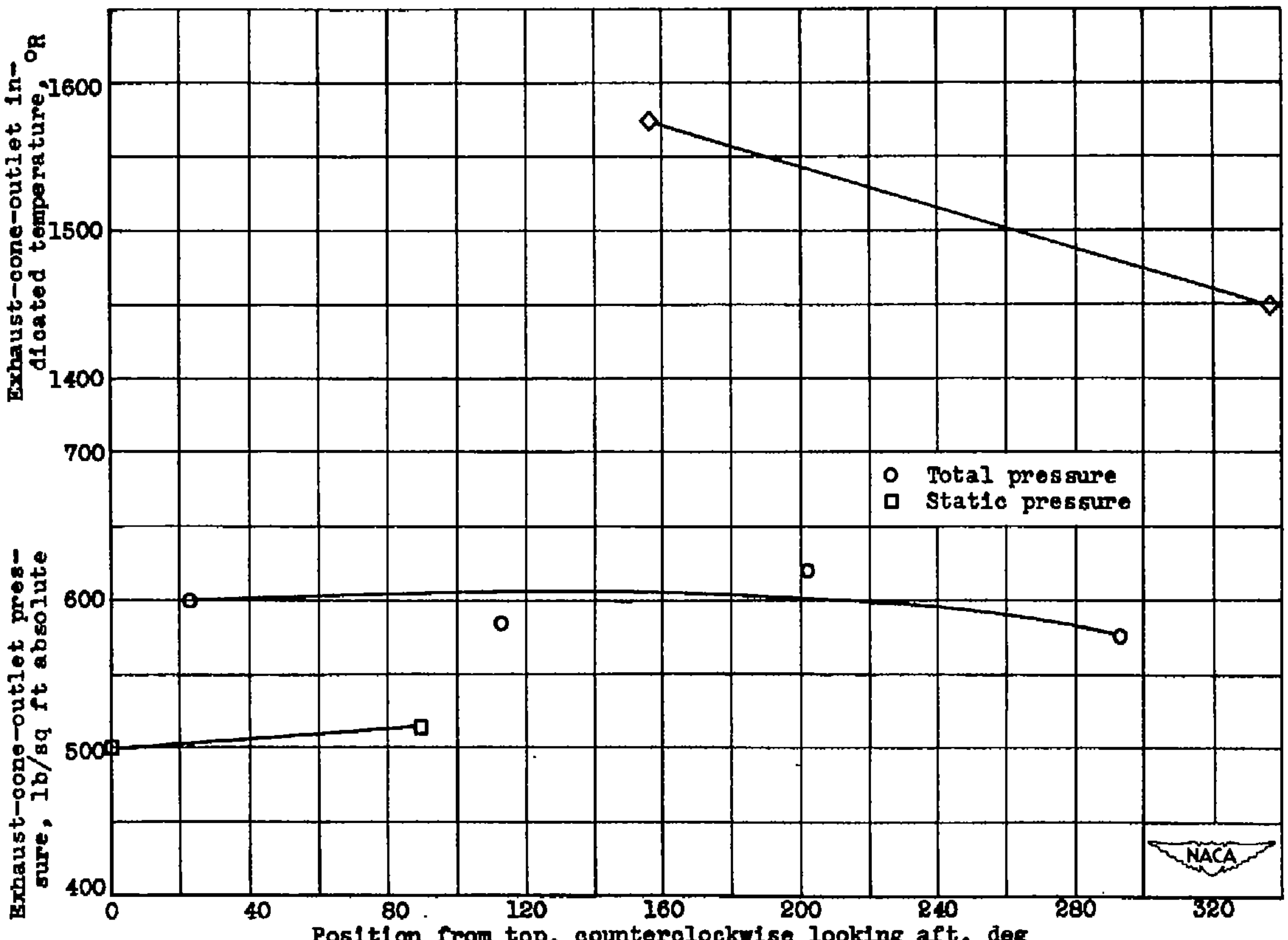
(a) Compressor-inlet ram-pressure ratio, 1.00; shaft horsepower, 340.

Figure 30. - Effect of compressor-inlet ram-pressure ratio on distribution of indicated temperature at turbine outlet. Altitude, 35,000 feet; engine speed, 13,000 rpm.



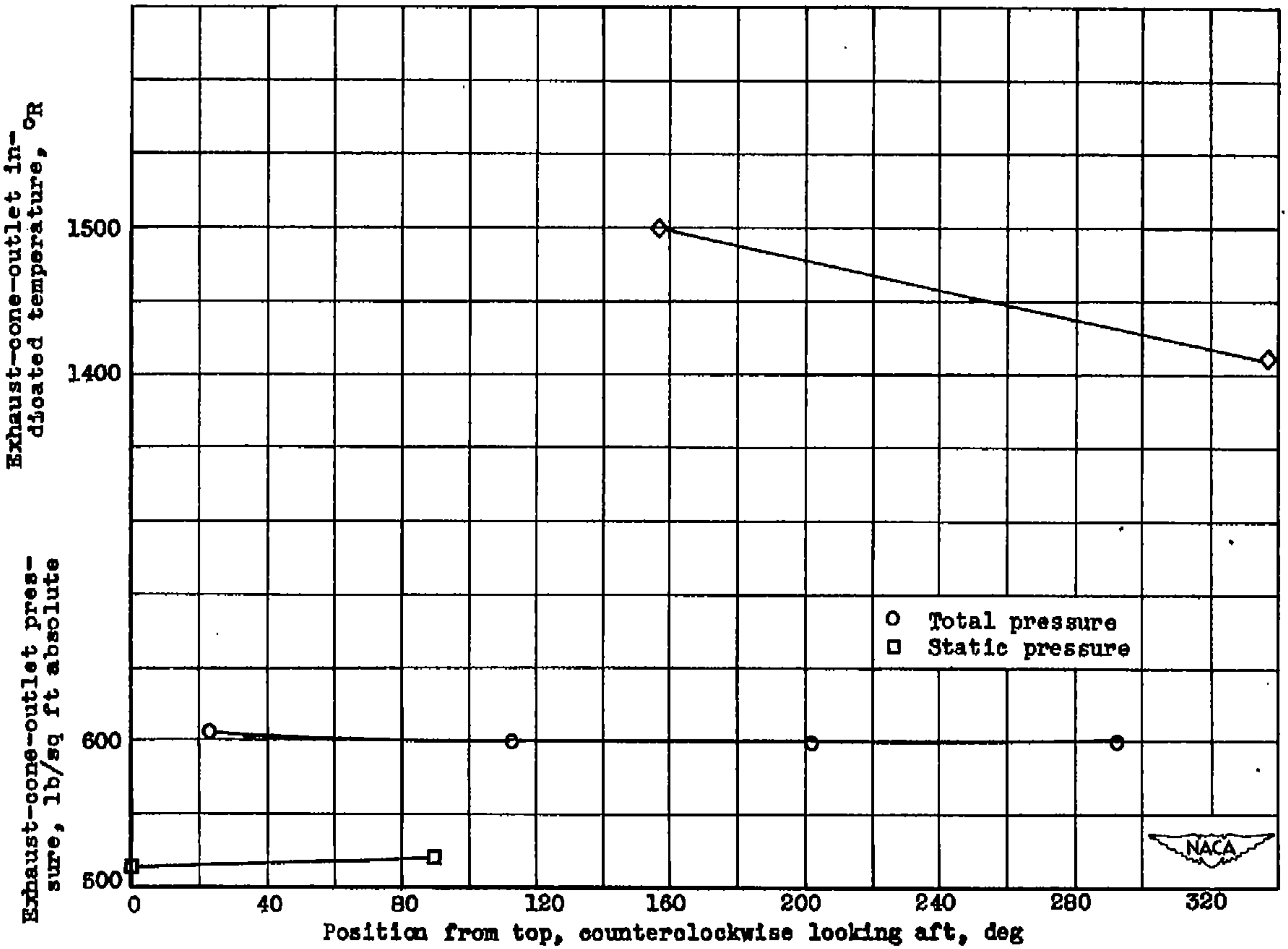
(b) Compressor-inlet ram-pressure ratio, 1.09; shaft horsepower, 330.

Figure 30. - Concluded. Effect of compressor-inlet ram-pressure ratio on distribution of indicated temperature at turbine outlet. Altitude, 35,000 feet; engine speed, 13,000 rpm.



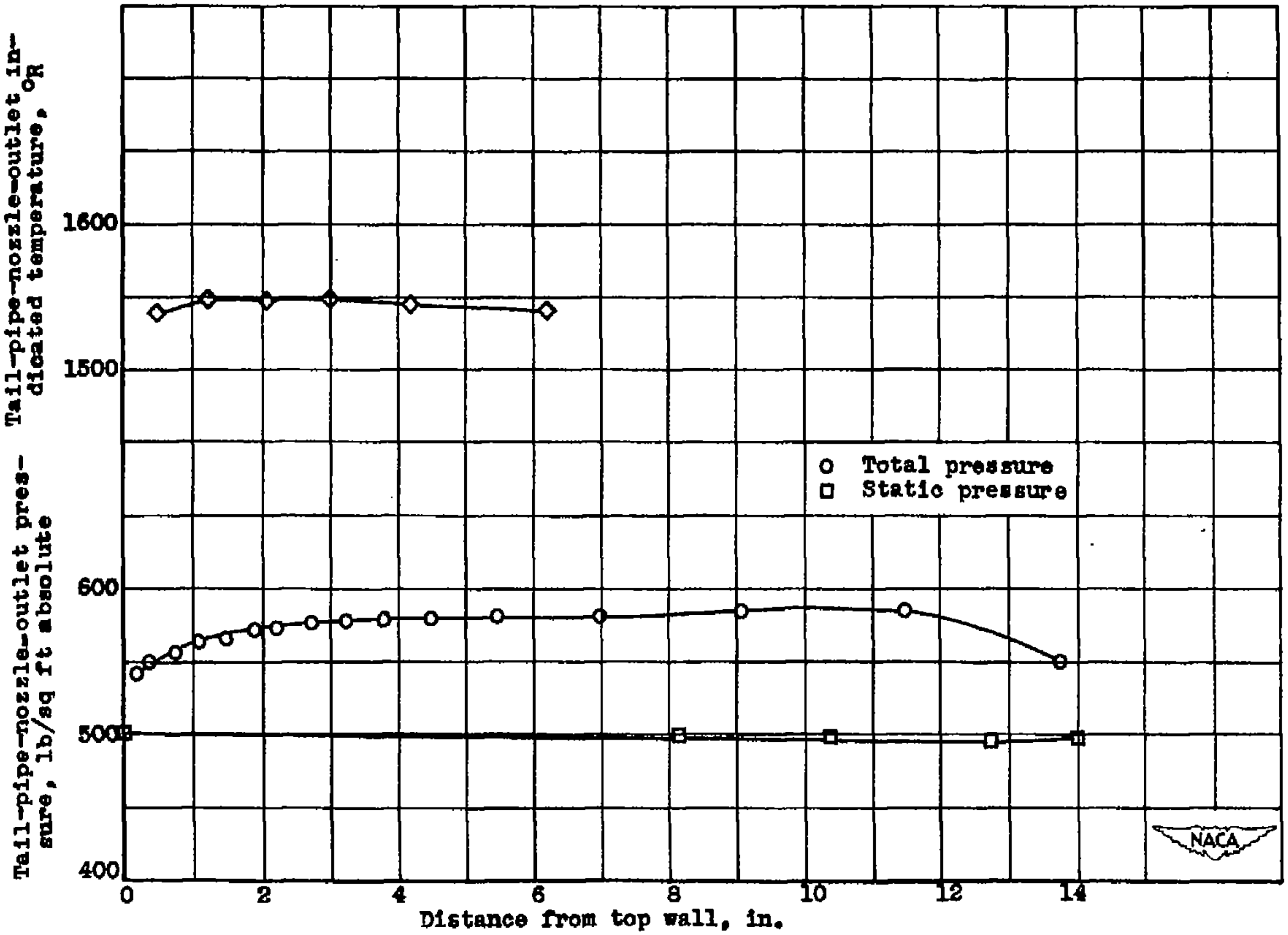
(a) Compressor-inlet ram-pressure ratio, 1.00; shaft horsepower, 340.

Figure 31. - Effect of compressor-inlet ram-pressure ratio on distribution of total pressure, static pressure, and indicated temperature at exhaust-cone outlet. Altitude, 35,000 feet; engine speed, 13,000 rpm.



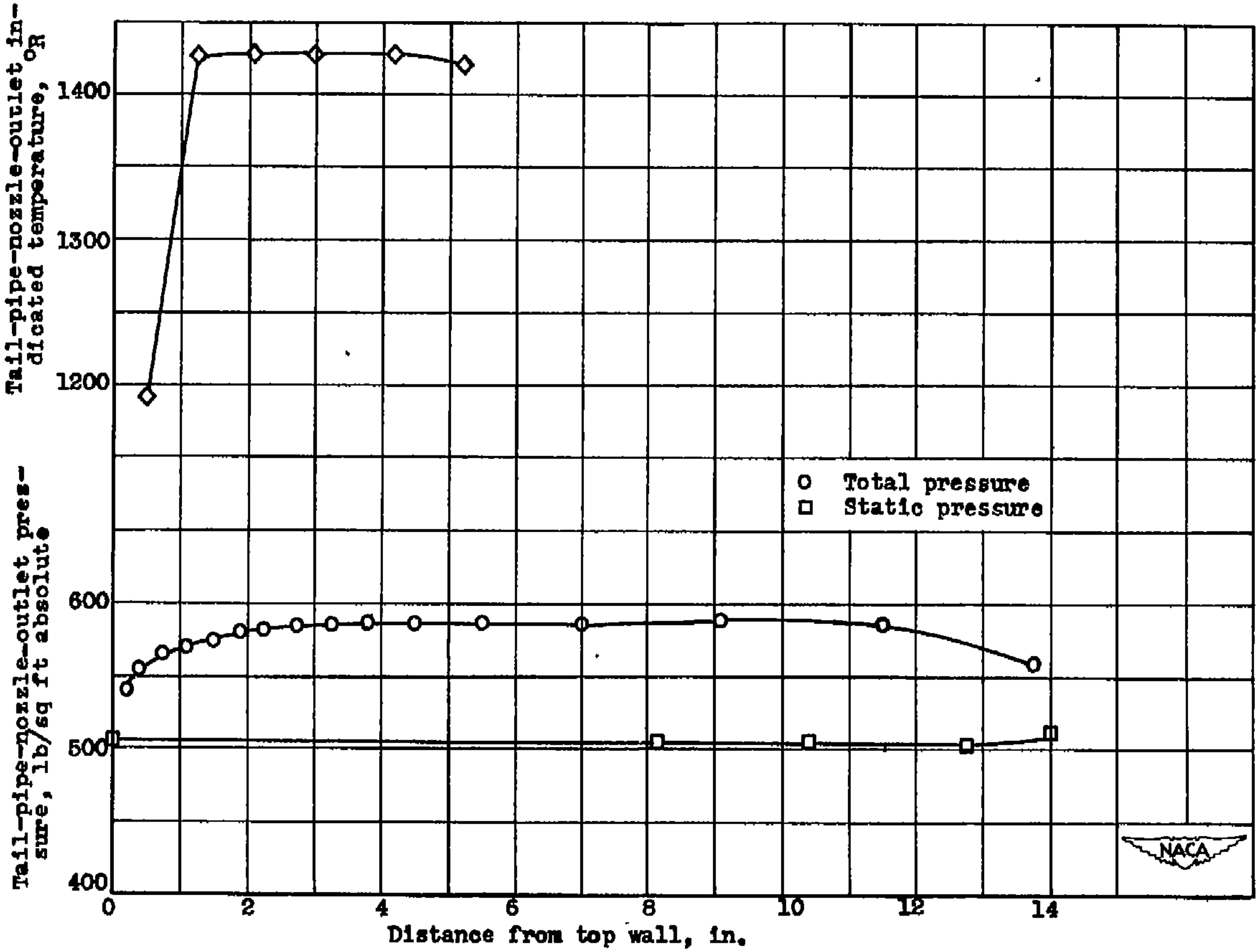
(b) Compressor-inlet ram-pressure ratio, 1.09; shaft horsepower, 330.

Figure 31. - Concluded. Effect of compressor-inlet ram-pressure ratio on distribution of total pressure, static pressure, and indicated temperature at exhaust-cone outlet. Altitude, 35,000 feet; engine speed, 13,000 rpm.



(a) Compressor-inlet ram-pressure ratio, 1.00; shaft horsepower, 340.

Figure 32. - Effect of compressor-inlet ram-pressure ratio on distribution of total pressure, static pressure, and indicated temperature at tail-pipe-nozzle outlet. Altitude, 35,000 feet; engine speed, 13,000 rpm.



(b) Compressor-inlet ram-pressure ratio, 1.09; shaft horsepower, 330.

Figure 32. - Concluded. Effect of compressor-inlet ram-pressure ratio on distribution of total pressure, static pressure, and indicated temperature at tail-pipe-nozzle outlet. Altitude, 35,000 feet; engine speed, 13,000 rpm.