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RESEARCH MEMORANDUM

PERFORMANCE OF DOUBLE-SHROUD EJECTOR CONFIGURATION WITH PRIMARY PRESSURE RATIOS FROM 1.0 TO 10

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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SUMMARY

A brief investigation was made to determine the performance characteristics of a double-shroud cooling-air ejector configuration. Two convergent primary nozzles were used to simulate a specific manufacturer's iris-type variable-area nozzle in the open and closed positions. The investigation comprised four phases: (1) obtaining performance with no secondary or tertiary air flow (cooling-air passages blocked), (2) determining the tendency for backflow to occur in either cooling-air passage, (3) determining the sensitivity of flow in one passage to that in the other, and (4) obtaining pumping and thrust characteristics with secondary and tertiary air flow.

The experimental results showed that the performance with the cooling-air passages blocked was typical of that for single ejectors having diameter and spacing ratios similar to those used in this investigation. There was a tendency for backflow to occur, but the magnitude of such flow was relatively small. The weight flow of each ejector was shown to be essentially independent of the other, and the closed primary-nozzle configuration was found to be generally capable of pumping more cooling-air than the open primary-nozzle configuration. Gains in gross thrust were observed for both configurations, with losses occurring only at low secondary and tertiary pressure ratios.

INTRODUCTION

The use of afterburners for thrust augmentation, and particularly the advent of high-temperature afterburners, increases the cooling-air requirements of turbojet engines. Single-shroud ejectors are now being used for supplying the cooling air. In some aircraft installations, however, it is necessary to provide an additional quantity of air for cooling the aircraft structure; the use of double-shroud ejectors for meeting this requirement is now under consideration.

The single-shroud ejector has been the subject of several experimental investigations (references 1 to 7), but the available information on double-shroud ejectors is very limited. In reference 8, the operating mechanism of double-shroud ejectors is discussed, the performance of several configurations is presented, and it is shown that an ejector of this type can be designed to operate satisfactorily.

The double-shroud ejector configurations used in this investigation incorporated two convergent primary nozzles to simulate a specific manufacturer's iris-type variable-area nozzle in the closed and open positions. Although this investigation was limited to only two configurations, a wider range of pressure ratios and operating conditions was covered than in the investigation reported in reference 8, which primarily presented the pumping and thrust characteristics of each configuration for only four primary pressure ratios. In the present investigation, the thrust and pumping characteristics of both configurations were investigated for eight constant primary pressure ratios from 1.10 to 9.5. Additional tests were conducted to determine (1) ejector performance with no cooling-air flow, (2) the tendency for backflow to occur from the primary jet into either the secondary or the tertiary system, and (3) whether or not the flow through each cooling-air system was independent of the flow through the other. This investigation was conducted using dry unheated air at a temperature of 80° F. 2765

SYMBOLS AND NOMENCLATURE

The following symbols and nomenclature used in this report are defined in the accompanying schematic sketch of a double-shroud ejector. It should be noted that primary refers to the engine nozzle, secondary denotes the inner annulus, and tertiary denotes the outer annulus:

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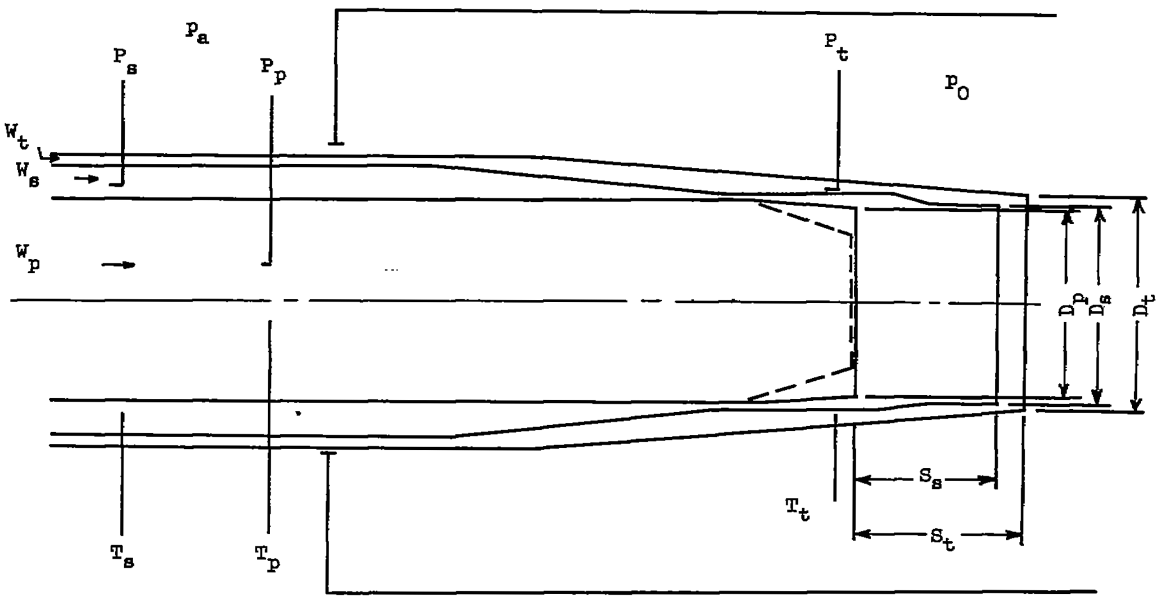

D_p	exit diameter of primary nozzle, in.
D_s	exit diameter of inner shroud, in.
D_t	exit diameter of outer shroud, in.
D_s/D_p	inner-shroud diameter ratio
D_t/D_p	outer-shroud diameter ratio
F_{ej}	gross thrust of ejector, lb
F_j	gross thrust of primary nozzle with shrouds removed, lb
F_{ej}/F_j	gross thrust ratio

P_p primary-stream total pressure, in. mercury abs.

P_s secondary-stream total pressure, in. mercury abs.

P_t tertiary-stream total pressure, in. mercury abs.

P_p/p_0 primary pressure ratio

P_s/p_0 secondary pressure ratio

P_t/p_0 tertiary pressure ratio 2765

p_a atmospheric pressure, in. mercury abs.

p_0 ambient exhaust pressure, in. mercury abs.

S_s distance from primary-nozzle exit to exit of inner shroud, inner-shroud spacing, in.

S_t distance from primary-nozzle exit to exit of outer shroud, outer-shroud spacing, in.

S_s/D_p inner-shroud spacing ratio

S_t/D_p outer-shroud spacing ratio

T_p primary-stream total temperature, $^{\circ}R$

T_s secondary-stream total temperature, $^{\circ}R$

T_t tertiary-stream total temperature, $^{\circ}R$

W_p primary weight flow, lb/sec

W_s secondary weight flow, lb/sec

W_t tertiary weight flow, lb/sec

W_s/W_p secondary weight-flow ratio

W_t/W_p tertiary weight-flow ratio

APPARATUS

Ejector Research Facility

The ejector-research facility shown in figure 1 consists of two concentric ducts simulating an engine tail pipe and a cooling-air passage. For this investigation, a third concentric duct was added to provide a cooling-air passage for the outer shroud. Air was supplied from the 2765 laboratory air-supply system to these ducts, as shown, and was passed through the primary nozzle and the cooling-air passages into the exhaust chamber. The air was supplied at a pressure of 40 pounds per square inch gage, a temperature of approximately 80° F, and a dew point of -20° F. The exhaust chamber was connected to the laboratory exhaust system so that the ejector exit pressure could be varied from atmospheric to about 2 pounds per square inch absolute.

The primary, secondary, and tertiary air flows were measured by means of standard A.S.M.E. sharp-edge orifices. The total pressures and temperatures were measured with total-pressure tubes and single, bare-wire, iron-constantan thermocouples, respectively. The primary measuring station, located 20 inches upstream of the primary-nozzle exit, consisted of two total-pressure tubes, two wall static taps, and one thermocouple. The total-pressure tubes and the thermocouple projected about one-third of the duct diameter into the stream, because surveys had shown that measurements at this location gave the average of the total-pressure profile. The secondary instrumentation, consisting of two total pressure tubes and one thermocouple, was located at a station about $27\frac{1}{2}$ inches upstream of the primary-nozzle exit. This instrumentation was duplicated for the tertiary stream at a station about $1\frac{1}{8}$ inches upstream of the primary-nozzle exit. The ejector exit pressure was measured in the exit plane of the outer shroud by means of two static-pressure tubes attached to the outside wall of the outer shroud.

The lower portion of the facility is connected to the laboratory-air supply system by means of flexible bellows and is pivoted to a steel frame in order that the axial force may be freely transmitted to a null-type balanced-pressure diaphragm, thrust-measuring cell. The output pressure of this cell is directly proportional to the applied force and, hence, is a direct measure of the resultant force acting on the ejector in an axial direction. In order that the force on the thrust cell would always be in one direction, an axial preload force, consisting of a counterweight connected to the rig by large pulleys and steel tapes, was applied to the thrust cell.

Ejector Models

In this investigation two conical nozzles having areas equivalent to a specific manufacturer's iris-type variable-area nozzle in the open and closed positions were used. The relative location of the shrouds with respect to the two primary nozzles is shown in figure 2. The open and closed primary nozzles had exit diameters of 4.79 and 3.49 inches, respectively, and the corresponding half-cone angles were 2°57' and 20°35'. The inside diameter of the approach pipe to the primary nozzles was 5 inches. The inner shroud was essentially cylindrical and had an exit diameter of 5.65 inches. The conical outer shroud had an exit diameter of 6.30 inches and a half-cone angle of 7°18'. The spacing and diameter ratios for both configurations are shown in the table in figure 2. 2765

PROCEDURE

Each of the two primary nozzles was calibrated to determine the flow coefficients and the primary nozzle thrust over a range of pressure ratios from 1.0 to 10. The various primary pressure ratios were obtained by throttling the inlet-air and by reducing the ambient pressure in the exhaust chamber. With the shrouds in place, the investigation of each complete double-shroud ejector configuration consisted of four phases. The first phase was an investigation of the performance over a range of primary pressure ratios from 1.0 to 10 with the shroud-inlet passages blocked (zero secondary and tertiary air flow). The second phase consisted in determining the tendency for backflow to occur in either of the two cooling-air passages and the magnitude of such flow. In order to accomplish this, the duct controlling the total air flow to the two cooling-air passages was blocked while the valves interconnecting the secondary and tertiary systems were open so as to allow air to circulate through the two interconnected systems.

The third phase was an investigation of the interaction and consequent sensitivity of each cooling-air system to the other. This phase was conducted at a constant primary pressure ratio of about 3.0; while the tertiary weight flow ratio, and hence the tertiary pressure ratio, was varied over a range of values, and the secondary weight flow ratio was so varied as to maintain a constant secondary pressure ratio of 1.30. In this way the effect of tertiary flow on the secondary weight-flow ratio was determined. The effect of secondary flow on the tertiary weight-flow ratio was determined in a similar manner; that is, by varying the secondary weight-flow ratio while a constant tertiary pressure ratio of 1.30 was being maintained.

The final phase was that of determining the pumping and thrust characteristics for a range of constant primary pressure ratios from 1.10 to 9.5. This phase was conducted with the total pressures in the two cooling passages approximately equal, so as to simulate a common inlet and plenum chamber for the two cooling-air passages. Although ejector performance was determined with 80° F primary, secondary, and tertiary air, the weight flow ratios presented herein are multiplied by $\sqrt{T_s/T_p}$ and $\sqrt{T_t/T_p}$ as a reminder that the application of these
2765 data to hot jet installations requires a temperature correction.

The axial force transmitted to the thrust cell was composed of the ejector thrust force, the pressure-area force imposed on the system by the difference between atmospheric pressure and the ejector exit pressure in the exhaust chamber, and the axial preload force. The pressure-area force was determined from a calibration over the range of ejector-exit pressures used in the investigation. The ejector thrust was obtained by subtracting the force acting on the thrust cell from the sum of the preload and the pressure-area forces. In order that the thrust data be consistent and accurate, the pressure-area force-calibration curve was checked daily throughout the investigation.

RESULTS AND DISCUSSION

Zero Secondary and Tertiary Flow

Performance. - The performance of the closed and the open primary-nozzle configurations with zero secondary and tertiary air flow is shown in figures 3(a) and 3(b) and in table I. The effect of primary pressure ratio on secondary pressure ratio is typical of single-shroud cylindrical ejectors having diameter and spacing ratios similar to those used in this investigation. The effect of primary pressure ratio on tertiary pressure ratio is typical of that of single-shroud conical ejectors having very small spacing ratios; such would be the case if the inner shroud were considered the primary nozzle and the spacing were the distance from the exit of the inner shroud to the exit of the outer shroud.

It should be noted that the curve of secondary pressure ratio in figure 3(a) exhibits a marked amount of hysteresis and the tertiary pressure ratio curve shows a slight amount of hysteresis in the primary pressure ratio range from 3.5 to 5.0 as indicated by the arrows on the curves. This phenomenon has previously been encountered with cylindrical ejectors having large diameter ratios and small spacing ratios, as shown in reference 1, but has not been observed for small diameter ratios. Hysteresis occurs because the primary jet remains attached to the shroud wall until the primary pressure ratio is decreased to a value less than that at which attachment first occurred as the primary pressure ratio was being increased. The jet finally becomes detached at this lower primary pressure ratio, and the shroud pressures assume their normal values. A further discussion of this hysteresis may be found in reference 1.

Thrust characteristics. - The effect of primary pressure ratio on gross thrust ratio for zero secondary and tertiary air flow is presented in figure 4(a) for the closed primary-nozzle configuration and in figure 4(b) for the open primary-nozzle configuration. Gross thrust ratio is defined as the ratio of ejector gross thrust F_{ej} to the primary 2765
nozzle (ejector shrouds removed) gross thrust F_j at the same primary pressure ratio. Ejector gross thrust F_{ej}, then, includes the combined thrust produced by the mass flow through the cooling-air passages, and the primary-nozzle gross thrust F_j includes only the thrust produced by the mass flow through the primary nozzle.

The thrust characteristics with the closed-nozzle configuration (fig. 4(a)) exhibit hysteresis similar to that for the secondary pressure ratio (fig. 3(a)), and indicate that a loss in gross thrust of as much as 33 percent of primary-nozzle gross thrust is possible with this configuration when the cooling-air flow is zero. Hysteresis did not occur for the open primary-nozzle configuration with zero cooling-air flow (fig. 4(b)); the greatest loss in gross thrust occurred at a primary pressure ratio of 2.0 and amounted to about 17 percent of the primary-nozzle gross thrust.

A comparison of figures 4(b) and 3(b) shows that the minimum gross thrust ratio occurred at the primary pressure ratio for which the secondary pressure ratio was a minimum, and that a slight dip occurred in the gross-thrust-ratio curve at the primary pressure ratio for which the tertiary pressure ratio was a minimum. This phenomenon may be attributed to shock losses accompanying the overexpansion of the primary jet. A more complete discussion of the effects of overexpansion and shock losses on ejector thrust may be found in reference 2.

A further comparison of figures 4(a) and 4(b) indicates that with zero secondary and tertiary flow, the gross thrust was higher with the open primary-nozzle configuration (small diameter ratio). This relation is consistent with the trends indicated by the data of reference 2.

Effect of Primary Pressure Ratio on Backflow

In order for backflow to occur in one of the two cooling-air passages, the pressure in one passage must be higher than the pressure in the other. An inspection of figures 3(a) and 3(b) indicates the regions of primary pressure ratio in which backflow will occur. That is, for the regions in which the secondary pressure ratio curve lies below the tertiary pressure ratio curve, (secondary pressure ratio is less than tertiary pressure ratio in figs. 3(a) and 3(b)), the circulation of air is in the normal direction through the secondary passage and is reversed through the tertiary system. For the opposite conditions of secondary and tertiary pressure ratio, the circulation is reversed.

2765 The effect of primary pressure ratio on backflow is shown in figures 5(a) and 5(b) and in table II for the closed and the open primary nozzles. The magnitude of the backflow, although measurable, was very small; less than 0.2 percent of primary air flow through the closed-nozzle configuration, and slightly exceeding 0.4 percent of primary air flow for the open-nozzle configuration. This test simulated a common inlet plenum chamber for the two cooling-air passages with no external source of air; the positive portion of each curve therefore indicates circulation in the normal direction through the secondary passage and in a reverse direction through the tertiary system. The negative portion of the curve indicates circulation in the opposite direction, with backflow occurring through the secondary system and flow in the normal direction existing in the tertiary passage. The direction of the circulation flow for each configuration reverses (magnitude of backflow becomes zero) at approximately the same primary pressure ratios at which the value of primary and secondary pressure ratio become equal (figs. 3(a) and 3(b)). It should be noted that the data of figure 5(a) were obtained in the direction of increasing primary pressure ratio, and thus any effect of hysteresis on backflow is not included.

Interaction of Secondary and Tertiary Systems

Investigation of the interaction between the secondary and tertiary flow systems indicated that there was little interaction between the two systems. The weight flow through each shroud was insensitive to changes through the other, as shown in table III and in figures 6 to 9 for the closed and the open primary nozzles. For a primary pressure ratio of about 3.0 and a secondary pressure ratio of about 1.3, with the primary nozzle in the closed position, the secondary weight-flow ratio was essentially independent of the tertiary weight-flow ratio as the tertiary weight-flow-ratio increased from 0.02 to 0.15 (fig. 6). Likewise, while varying the secondary weight-flow ratio with the primary nozzle closed, the tertiary weight-flow ratio was essentially constant for a constant tertiary pressure ratio of about 1.3 (fig. 7). Similar results were obtained for the open primary-nozzle configuration (figs. 8 and 9). Although this effect was investigated only at a primary pressure ratio of about 3.0, it is believed that these characteristics are representative of those which would be obtained at other primary pressure ratios.

Ejector Performance

Pumping characteristics. - The pumping characteristics of the double-shroud ejector configuration with the closed primary nozzle are presented in figure 10 for several primary pressure ratios from 1.10 to 9.5, and are tabulated in table IV. As mentioned previously, the total pressures in the two cooling passages were maintained approximately equal for this phase of the investigation. The effect of secondary pressure ratio on secondary weight-flow ratio is shown in figure 10(a), and the corresponding tertiary-system pumping characteristics are shown in figure 10(b). A comparison of the two figures discloses that the pumping ability of the secondary and the tertiary systems are nearly identical. It is evident from these data that at low primary pressure ratios secondary and tertiary weight-flow ratios were extremely sensitive to variations in secondary and tertiary pressure ratios. As the primary pressure ratio was increased this sensitivity of secondary and tertiary flow became less pronounced. 2765

The secondary and the tertiary weight-flow ratios with the open primary nozzle are shown in figures 11(a) and 11(b), respectively, and in table IV. A comparison of these figures reveals that the secondary outperforms the tertiary system at the lower primary pressure ratios over the entire range of secondary and tertiary pressure ratio, and at primary pressure ratios of 3.0 and 4.0 at the lower secondary and tertiary pressure ratios. For the three highest primary pressure ratios investigated (6.0, 8.0, and 9.5), the tertiary system pumps a far greater amount of air than the secondary. Again, the sensitivity of the weight-flow ratios to changes in secondary and tertiary pressure ratio decreased greatly with increasing primary pressure ratio.

A comparison of figures 10 and 11 shows that, for a given primary pressure ratio, the weight-flow ratios for the open primary-nozzle configuration are, in general, considerably lower than for the closed-primary configuration. This comparison also discloses, as pointed out in reference 8, that for the closed primary-nozzle configuration (large diameter ratio), the secondary and tertiary weight-flow ratios were more sensitive to changes in secondary and tertiary pressure ratio for any particular primary pressure ratio, than for the open primary-nozzle configuration (small diameter ratio). The open primary-nozzle configuration will, however, pump secondary and tertiary air over a wider range of secondary and tertiary pressure ratios and will start pumping at a lower primary pressure ratio. These comparisons indicate that ejector performance is not compatible with afterburner-cooling requirements, in that there is a great excess of air for the nonafterburning (closed primary nozzle) condition. Also, because the required tertiary flow is generally about one-fifth that required for the secondary system, there is a great excess of tertiary air for most conditions. As pointed out in reference 8, such an excess of tertiary air flow can be reduced by decreasing the tertiary diameter and spacing ratios to values slightly larger than the secondary diameter and spacing ratios.

Thrust characteristics. - The effect of secondary and tertiary pressure ratio on gross thrust ratio is shown in table IV and in figures 12(a) and 12(b) for the closed and open primary-nozzle configurations, respectively. For the closed-primary nozzle, a gain in gross thrust was obtained for all primary pressure ratios, although with primary pressure ratios of 8.0 and 9.5 there was a loss in gross thrust at secondary and tertiary pressure ratios below about 1.0. These losses were as much as 4 percent and $4\frac{1}{2}$ percent, respectively, at the primary pressure ratios of 8.0 and 9.5. Data for a primary pressure ratio of 1.10 indicated that a gain in gross thrust of about 34 percent was obtainable, which was due, in most part, to the relatively large mass flow through the secondary and tertiary systems. Data for the open nozzle (fig. 12(b)) also show that a gross thrust gain is obtainable for all primary pressure ratios, with losses occurring at the low secondary and tertiary pressure ratios for primary pressure ratios of 1.10, 1.50, 4.0, and 6.0.

A comparison of figures 12(a) and 12(b) reveals the same general thrust trends that were observed in the earlier investigation of double-shroud ejectors (reference 8). These curves also follow the same general trends as the weight-flow curves in figures 10 and 11; namely, that for any given primary pressure ratio, the thrust curves for the closed primary nozzle lie above those of the open-nozzle configuration. This is due, in part, to the greater secondary and tertiary mass flows at given secondary and tertiary pressure ratios for the closed primary-nozzle configuration. Also the greater expansion ratio of the closed primary nozzle would contribute to higher thrust ratios at the high primary pressure ratios. Although the higher thrust ratios were obtained with the closed primary-nozzle configuration, it does not necessarily follow that this is the best configuration, in view of the large amount of secondary and tertiary air that is being pumped.

The sensitivity of the gross thrust ratio to changes in secondary and tertiary pressure ratio is, in general, less for the open primary-nozzle configuration. Furthermore, for each configuration this sensitivity to secondary and tertiary pressure ratio decreases as the primary pressure ratio increases.

Application of Data

As pointed out in reference 8, the performance of an ejector in an actual installation will depend upon the performance of the ejector itself as a pump and upon the performance of the cooling-air flow system for a range of operating conditions. Also, a correction must be applied to the weight-flow ratios to take into consideration the ratio of cooling-air temperature to engine-gas temperature, as described in reference 3. However, this correction may not be valid under all conditions, particularly at the high temperature ratios; some error may therefore result, as indicated in reference 4. However, the comparisons of full-scale and model-ejector data shown in this reference are believed to show greater discrepancies than would have been the case had the configurations been exact scale models of the ejectors used. Until more complete high-temperature ejector data are available, the data presented herein should give an indication of trends to be expected from double-shroud ejectors having similar configurations and will serve as a supplement to the data contained in reference 8.

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CONCLUDING REMARKS

Data obtained with a double-shroud ejector configuration, using two different size convergent primary nozzles in order to simulate a specific manufacturer's variable-area iris-type nozzle in the closed and in the open positions, indicated that the performance with the cooling-air passages blocked was typical of that for single ejectors having similar diameter and spacing ratios. Also indicated was a possible gross thrust loss of as great as 33 percent of primary-nozzle gross thrust with the primary nozzle in the closed position and with no cooling-air flow. For the open-primary-nozzle configuration and no cooling-air flow, the thrust losses were reduced to 17 percent of primary-nozzle gross thrust. For both configurations the magnitude of backflow was relatively small. There was very little interaction between the secondary and tertiary flow systems as each system was essentially unaffected by changes in flow through the other. A comparison of the pumping characteristics for both configurations indicates that, in general, the closed primary-nozzle configuration is capable of pumping more cooling air; whereas the open-nozzle configuration will pump over a greater range of secondary and tertiary pressure ratios.

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TABLE I - PERFORMANCE WITH ZERO SECONDARY AND TERTIARY FLOW

Run	Primary-stream total pressure P_p (in. mercury absolute)	Secondary-stream total pressure P_s (in. mercury absolute)	Tertiary-stream total pressure P_t (in. mercury absolute)	Ambient exhaust pressure p_0 (in. mercury absolute)	Primary weight flow W_p (lb/sec)	Secondary weight flow W_s (lb/sec)	Tertiary weight flow W_t (lb/sec)	Gross thrust of primary nozzle with shrouds removed F_j (lb) (a)	Gross thrust of ejector F_{ej} (lb)	Primary-stream total temperature T_p (°R)	Secondary-stream total temperature T_s (°R)	Tertiary-stream total temperature T_t (°R)	Primary pressure ratio P_p/p_0	Secondary pressure ratio P_s/p_0	Tertiary pressure ratio P_t/p_0	Secondary weight-flow ratio $\frac{W_s}{W_p}\sqrt{\frac{T_s}{T_p}}$	Tertiary weight-flow ratio $\frac{W_t}{W_p}\sqrt{\frac{T_t}{T_p}}$	Gross-thrust ratio F_{ej}/F_j
Primary-nozzle position, closed																		
1	30.19	14.94	14.86	14.99	2.82	0	0	97.9	107.4	551.0	----	----	2.014	0.9967	0.9907	0	0	1.097
2	30.34	12.00	11.90	12.05	3.02	0	0	115.5	121.8	551.0	----	----	2.518	.9959	.9876	0	0	1.055
3	30.59	9.79	9.75	9.80	3.05	0	0	126.9	130.5	551.0	----	----	3.090	.9989	.9948	0	0	1.030
4	34.64	9.77	9.73	9.98	3.44	0	0	149.1	156.4	551.5	----	----	3.471	.9819	.9779	0	0	1.049
5	38.89	9.49	9.59	9.83	3.87	0	0	174.5	178.5	551.0	----	----	3.958	.9654	.9758	0	0	1.024
6	44.84	9.17	9.66	9.98	4.50	0	0	207.6	209.0	551.5	----	----	4.507	.9215	.9709	0	0	1.007
7	49.09	3.82	9.61	10.22	4.94	0	0	250.3	188.0	550.0	----	----	4.803	.3739	.9599	0	0	.7505
8	50.29	3.88	9.53	9.84	5.06	0	0	258.4	182.0	551.5	----	----	5.079	.3916	.9648	0	0	.7050
9	55.29	4.21	9.54	9.98	5.58	0	0	265.4	221.1	550.0	----	----	5.557	.4231	.9588	0	0	.829
10	48.62	9.81	9.44	9.78	4.85	0	0	219.7	213.5	547.5	----	----	4.980	.9998	.9642	0	0	1.005
11	47.07	3.50	10.18	10.69	4.79	0	0	217.2	162.6	549.0	----	----	4.449	.3304	.9613	0	0	.7498
12	40.88	3.03	9.78	10.17	4.05	0	0	180.3	128.0	549.0	----	----	3.958	.2979	.9597	0	0	.7100
13	38.17	2.89	9.61	10.04	3.84	0	0	157.9	108.8	549.0	----	----	3.803	.2878	.9572	0	0	.6880
14	35.08	9.54	9.35	9.57	3.62	0	0	155.6	156.0	549.0	----	----	3.659	.9760	.9749	0	0	1.009
15	45.17	8.96	9.49	9.63	4.55	0	0	209.9	209.7	549.0	----	----	4.589	.9118	.9864	0	0	.9989
16	47.32	8.45	9.48	9.82	4.80	0	0	222.2	217.9	549.0	----	----	4.819	.8585	.9655	0	0	.9795
17	48.62	7.85	9.48	9.88	4.92	0	0	229.3	220.4	549.0	----	----	4.921	.8047	.9596	0	0	.9613
18	49.87	3.70	9.97	10.39	5.06	0	0	232.8	180.5	549.0	----	----	4.781	.3561	.9598	0	0	.7757
19	49.42	3.63	9.47	9.88	5.01	0	0	233.8	184.9	549.0	----	----	5.002	.3674	.9585	0	0	.7908
20	55.47	4.03	9.34	9.80	5.62	0	0	266.5	222.5	549.0	----	----	5.660	.4112	.9531	0	0	.8357
21	59.97	4.34	9.57	10.07	6.09	0	0	292.7	247.4	549.8	----	----	5.965	.4310	.9503	0	0	.8451
22	65.92	4.74	9.18	9.77	6.66	0	0	327.8	285.1	549.5	----	----	6.747	.4852	.9398	0	0	.8696
23	70.87	5.00	9.15	9.82	7.13	0	0	358.1	318.4	549.0	----	----	7.188	.5092	.9318	0	0	.8906
24	70.17	5.01	8.40	9.20	7.10	0	0	354.8	317.1	549.0	----	----	7.627	.5446	.9130	0	0	.8942
25	75.47	5.33	8.02	9.28	7.68	0	0	384.5	350.6	549.0	----	----	8.133	.5744	.8642	0	0	.9120
26	78.37	5.31	6.42	8.50	7.82	0	0	387.8	353.4	549.0	----	----	8.867	.6247	.7553	0	0	.9120
27	75.67	5.26	5.43	8.10	7.65	0	0	390.4	358.5	549.0	----	----	9.330	.6494	.6704	0	0	.9182
28	75.97	5.26	4.95	7.80	7.69	0	0	394.2	359.8	549.0	----	----	9.740	.6789	.6359	0	0	.9127
29	77.37	5.36	4.89	7.57	7.81	0	0	403.1	369.7	549.0	----	----	10.22	.7080	.6198	0	0	.9171
30	32.77	9.41	9.38	9.56	3.30	0	0	140.9	145.0	548.0	----	----	3.429	.9843	.9791	0	0	1.029
31	29.97	9.66	9.77	9.97	3.08	0	0	125.1	126.1	547.5	----	----	3.006	.9880	.9799	0	0	1.016
Primary-nozzle position, open																		
1	29.95	26.01	27.05	27.25	3.90	0	0	46.4	44.08	539.0	----	----	1.099	0.9552	0.9934	0	0	0.9489
2	30.06	22.07	23.82	24.11	3.25	0	0	95.1	86.55	538.0	----	----	1.248	.9154	.9880	0	0	.9098
3	29.95	17.47	19.84	19.91	3.50	0	0	141.7	135.8	537.0	----	----	1.503	.8774	.9834	0	0	.9582
4	30.93	14.41	16.77	17.12	3.89	0	0	172.6	167.8	537.0	----	----	1.786	.8417	.9796	0	0	.9664
5	30.13	12.06	15.15	15.50	3.94	0	0	190.7	178.5	538.0	----	----	1.944	.7774	.9774	0	0	.9361
6	30.13	11.14	14.78	15.13	3.96	0	0	194.4	173.9	538.0	----	----	1.991	.7363	.9769	0	0	.8930
7	30.18	5.27	14.44	14.83	3.95	0	0	198.8	169.0	538.0	----	----	2.021	.4200	.9695	0	0	.8593
8	30.85	5.48	13.18	13.42	3.94	0	0	209.9	179.8	538.0	----	----	2.283	.4085	.9808	0	0	.8575
9	30.98	5.37	11.65	11.90	3.82	0	0	218.9	197.7	538.0	----	----	2.588	.4513	.9790	0	0	.9030
10	30.98	6.84	9.65	10.10	3.83	0	0	235.6	218.9	538.0	----	----	2.978	.5987	.9738	0	0	.9211
11	40.08	6.94	9.58	9.85	7.00	0	0	346.2	333.8	539.0	----	----	4.058	.7029	.9627	0	0	.9636
12	48.85	8.56	9.29	9.94	9.82	0	0	455.8	444.4	540.0	----	----	5.025	.8612	.9548	0	0	.9796
13	54.45	9.27	9.26	10.14	10.69	0	0	500.5	488.9	540.0	----	----	5.347	.9106	.9096	0	0	.9789
14	54.43	9.21	6.55	8.94	10.89	0	0	517.8	495.4	540.5	----	----	6.072	1.026	.7294	0	0	.9576
15	54.85	9.28	4.96	8.18	10.78	0	0	523.5	506.2	541.5	----	----	6.705	1.151	.6081	0	0	.9671
16	54.93	9.23	4.64	7.48	10.76	0	0	531.1	519.7	541.0	----	----	7.573	1.239	.6226	0	0	.9784
17	56.08	9.26	4.55	6.70	10.80	0	0	539.2	531.1	541.0	----	----	8.213	1.362	.6781	0	0	.9850
18	55.05	9.84	4.48	6.10	10.77	0	0	544.6	540.4	541.5	----	----	9.031	1.515	.7311	0	0	.9921
19	55.85	9.34	4.45	5.34	10.88	0	0	557.7	548.7	541.5	----	----	10.42	1.735	.8275	0	0	.9861
20	56.43	9.54	4.42	4.85	10.88	0	0	550.7	560.3	541.5	----	----	11.64	1.898	.9096	0	0	1.001
21	56.85	9.39	4.40	7.89	10.96	0	0	538.8	525.1	541.5	----	----	7.089	1.190	.8084	0	0	.9775
22	55.75	9.36	4.39	8.30	10.62	0	0	532.0	520.5	540.5	----	----	6.714	1.127	.8019	0	0	.9761
23	55.28	8.95	5.15	8.30	10.39	0	0	505.4	494.1	540.0	----	----	6.413	1.076	.6181	0	0	.9775
24	53.38	9.01	6.89	8.81	10.41	0	0	501.8	487.7	540.0	----	----	6.048	1.025	.7480	0	0	.9718
25	53.08	9.99	8.49	9.71	10.38	0	0	490.4	481.3	531.5	----	----	5.467	.9258	.8960	0	0	.9815
26	53.15	9.10	9.96	10.85	10.35	0	0	488.4	472.8	539.5	----	----	4.989	.8845	.8371	0	0	.9801
27	53.85	9.18	11.18	11.70	10.39	0	0	473.6	463.8	539.5	----	----	4.580	.7848	.9530	0	0	.9795
28	53.15	9.17	13.14	13.88	10.36	0	0	454.7	443.0	538.5	----	----	3.901	.6733	.9848	0	0	.9743
29	40.23	7.06	11.54	11.90	7.80	0	0	329.8	314.3	538.5	----	----	3.381	.5855	.9687	0	0	.9531
30	40.15	7.08	14.11	14.46	7.41	0	0	306.0	280.8	538.5	----	----	2.776	.4896	.9758	0	0	.9208
31	30.18	6.47	13.98	13.98	5.90	0	0	210.4	188.6	538.4	----	----	2.073	.4119	.9804	0	0	.8863
32	30.18	6.16	14.46	14.88	5.91	0	0	198.9	188.7	538.5	----	----	2.027	.4137	.9711	0	0	.8417
34	30.15	11.67	15.01	15.38	5.91	0	0	192.0	181.5	538.5	----	----	1.962	.7586	.9772	0	0	.9444
36	30.18	14.51	16.86	17.20	5.90	0	0	174.1	165.0	538.2	----	----	1.754	.8436	.9787	0	0	.9475
37	30.23	6.42	14.72	16.19	5.80	0	0	184.7	161.4	538.2	----	----	1.860	.4226	.8981	0	0	.8282

[a] Values obtained from nozzle calibration.

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TABLE II - EFFECT OF PRIMARY PRESSURE RATIO ON BACKFLOW

Run	Primary-stream total pressure P_p (in. mercury absolute)	Secondary-stream total pressure P_s (in. mercury absolute)	Tertiary-stream total pressure P_t (in. mercury absolute)	Ambient exhaust pressure p_0 (in. mercury absolute)	Primary weight flow W_p (lb/sec)	Secondary weight flow W_s (lb/sec) (a)	Tertiary weight flow W_t (lb/sec) (a)	Gross thrust of primary nozzle with shrouds removed F_j (lb) (b)	Gross thrust of ejector F_{ej} (lb)	Primary-stream total temperature T_p (°R)	Secondary-stream total temperature T_s (°R)	Tertiary-stream total temperature T_t (°R)	Primary pressure ratio P_p/p_0	Secondary pressure ratio P_s/p_0	Tertiary pressure ratio P_t/p_0	Secondary weight-flow ratio $\frac{W_s}{W_p}\sqrt{\frac{T_s}{T_p}}$ (a)	Tertiary weight flow ratio $\frac{W_t}{W_p}\sqrt{\frac{T_t}{T_p}}$ (a)	Gross-thrust ratio F_{ej}/F_j
Primary-nozzle position, closed																		
1	30.21	28.68	28.70	28.81	1.72	-0.00111	0.00111	24.84	24.17	538.0	540.0	542.0	1.127	0.9962	0.9859	-0.00065	0.00065	0.9807
2	29.71	23.71	23.76	23.87	2.20	-.00249	.00249	40.70	41.85	538.0	541.0	541.0	1.245	.9933	.9954	-.00115	.00115	1.031
3	29.81	19.58	19.64	19.78	2.67	-.00387	.00387	68.08	72.52	538.0	542.0	541.0	1.512	.9899	.9929	-.00145	.00145	1.065
4	29.86	17.07	17.17	17.29	2.78	-.00364	.00364	82.86	90.30	538.0	542.0	541.0	1.727	.9873	.9931	-.00131	.00131	1.092
5	30.11	14.86	14.97	15.06	2.92	-.00322	.00322	97.03	104.5	538.0	542.0	540.0	1.997	.9854	.9927	-.00112	.00112	1.077
6	29.81	11.78	11.84	11.95	2.97	-.00244	.00244	112.6	122.3	538.0	542.0	540.0	2.495	.9858	.9908	-.00082	.00082	1.086
7	29.81	9.92	10.0	10.10	2.97	-.00251	.00251	122.2	128.0	538.0	542.0	538.0	2.951	.9822	.9901	-.00084	.00084	1.048
8	40.31	9.39	9.59	9.86	4.00	-.00162	.00162	182.3	189.1	539.0	543.0	538.0	4.092	.9533	.9735	-.00040	.00040	1.038
9	50.06	8.01	9.80	10.03	5.08	.00706	-.00706	236.7	228.2	538.0	542.0	536.0	4.991	.7986	.9571	.00139	-.00139	.9659
10	60.16	4.79	9.15	9.82	6.09	.0121	-.0121	294.9	258.8	538.0	542.0	531.0	6.126	.4878	.9318	.00198	-.00198	.8775
11	70.66	5.39	9.09	10.01	7.12	.0118	-.0118	352.9	319.2	539.0	542.0	532.0	7.049	.5385	.9081	.00166	-.00166	.9044
12	78.81	5.95	8.21	9.88	7.88	.00758	-.00758	400.3	364.7	539.0	543.0	530.0	7.969	.6016	.8501	.00095	-.00095	.9108
13	79.61	5.78	6.37	8.97	8.06	.00559	-.00559	409.2	373.3	539.0	543.0	528.0	8.875	.6444	.7101	.00069	-.00069	.9121
14	80.01	5.58	5.21	8.14	8.12	-.00408	.00408	415.4	386.1	539.0	543.0	527.0	9.828	.6818	.6400	-.00050	.00050	.9293
15	79.76	5.50	4.99	7.75	8.10	-.00524	.00524	415.7	385.4	539.0	542.0	526.0	10.28	.7066	.6430	-.00065	.00065	.9270
Primary-nozzle position, open																		
16	30.03	28.10	27.01	27.18	3.95	0.0154	-0.0154	49.06	44.79	550.0	548.0	543.0	1.105	0.9603	0.9937	0.0039	-0.0039	0.9131
17	50.08	22.56	23.90	24.20	5.15	.0185	-.0185	92.25	88.88	548.0	547.0	543.0	1.243	.9240	.9876	.0036	-.0036	.9640
18	29.98	17.90	19.84	20.20	5.75	.0190	-.0190	139.1	128.7	547.0	548.0	543.0	1.484	.8861	.9822	.0033	-.0033	.9252
19	29.68	14.83	16.89	17.26	5.76	.0179	-.0179	170.2	182.1	546.0	544.0	543.0	1.731	.8592	.9786	.0031	-.0031	.9522
20	30.05	11.89	14.71	15.06	5.81	.0186	-.0186	193.8	182.0	546.0	543.0	543.0	1.991	.7885	.9755	.0032	-.0032	.9391
21	30.13	6.64	13.41	13.78	5.80	.0244	-.0244	205.7	180.6	548.0	541.0	543.0	2.187	.4819	.9731	.0042	-.0042	.8762
22	30.06	6.28	11.59	11.89	5.81	.0205	-.0203	219.0	202.6	546.0	541.0	543.0	2.530	.5282	.9748	.0035	-.0035	.9248
23	29.93	6.05	9.74	10.04	5.77	.0162	-.0162	254.4	221.1	546.0	538.0	543.0	2.981	.6026	.9701	.0028	-.0028	.9433
24	40.23	7.53	9.61	10.01	7.79	.0125	-.0125	347.3	337.7	546.0	538.0	543.0	4.019	.7522	.9600	.0016	-.0016	.9721
25	49.83	8.76	9.45	10.07	9.70	.0058	-.0058	451.4	441.5	546.0	536.0	542.0	4.946	.8699	.9394	.0006	-.0006	.9784
26	50.43	8.42	6.66	8.18	9.82	-.0079	.0079	475.4	472.8	546.0	537.0	542.0	6.165	1.029	.8142	-.0008	.0008	.9946
27	46.63	8.30	8.28	8.99	9.45	0	0	448.3	441.6	546.0	536.0	542.0	5.409	.9232	.9210	0	0	.9846
28	50.53	8.32	5.27	7.35	9.80	-.0108	.0108	482.1	470.0	546.0	536.0	542.0	6.866	1.135	.7190	-.0011	.0011	.9751
29	50.33	8.29	4.66	6.43	9.81	-.0108	.0108	490.4	481.3	546.0	536.0	542.0	7.827	1.289	.7278	-.0011	.0011	.9812
30	50.25	8.26	5.54	5.40	9.81	-.0118	.0118	498.8	485.6	546.0	536.0	542.0	9.302	1.530	1.026	-.0012	.0012	.9835

[a] Negative values indicate blackflow.

[b] Values obtained from nozzle calibration.

TABLE III - INTERACTION OF SECONDARY AND TERTIARY SYSTEMS

Run	Primary-stream total pressure P_p (in. mercury absolute)	Secondary-stream total pressure P_s (in. mercury absolute)	Tertiary-stream total pressure P_t (in. mercury absolute)	Ambient exhaust pressure p_0 (in. mercury absolute)	Primary weight flow W_p (lb/sec)	Secondary weight flow W_s (lb/sec)	Tertiary weight flow W_t (lb/sec)	Gross thrust of primary nozzle with shrouds removed F_j (lb) [a]	Gross thrust of ejector F_{ej} (lb)	Primary-stream total temperature T_p (°R)	Secondary-stream total temperature T_s (°R)	Tertiary-stream total temperature T_t (°R)	Primary pressure ratio P_p/p_0	Secondary pressure ratio P_s/p_0	Tertiary pressure ratio P_t/p_0	Secondary weight-flow ratio $\frac{W_s}{W_p}\sqrt{\frac{T_s}{T_p}}$	Tertiary weight flow ratio $\frac{W_t}{W_p}\sqrt{\frac{T_t}{T_p}}$	Gross-thrust ratio F_{ej}/F_j
								Primary-nozzle position, closed										
1	29.96	13.03	10.02	10.0	3.04	0.581	0.058	122.9	127.3	538.0	534.0	530.0	2.998	1.303	1.002	0.1902	0.0189	1.038
2	29.91	13.02	10.11	10.0	3.03	.584	.132	122.7	126.6	539.5	535.5	533.0	2.991	1.302	1.011	.1920	.0433	1.032
3	29.91	13.03	10.27	10.0	3.03	.584	.198	122.6	125.8	540.5	537.5	536.0	2.991	1.303	1.027	.1922	.0654	1.026
4	29.96	13.02	10.52	10.0	3.03	.586	.272	122.9	128.7	541.0	538.5	537.5	2.996	1.302	1.052	.1930	.0896	1.047
5	29.86	13.04	10.93	10.02	3.03	.588	.342	122.3	127.3	542.0	539.0	537.5	2.980	1.301	1.091	.1938	.1124	1.041
6	29.86	13.02	11.69	10.0	3.03	.587	.456	122.4	133.0	542.0	539.5	538.0	2.986	1.302	1.169	.1933	.1499	1.087
7	29.76	10.07	13.03	10.01	3.02	.275	.597	121.7	133.0	542.0	540.0	539.5	2.973	1.000	1.302	.0909	.1972	1.093
8	29.86	10.28	13.03	10.0	3.02	.317	.595	122.3	134.4	544.5	540.5	539.5	2.986	1.028	1.303	.1046	.1961	1.099
9	29.86	10.99	13.04	10.0	3.02	.427	.599	122.3	137.2	545.0	541.0	540.5	2.986	1.099	1.304	.1409	.1975	1.122
10	29.86	13.18	13.06	10.01	3.02	.592	.597	122.3	135.1	545.5	542.5	540.5	2.983	1.317	1.306	.1955	.1968	1.106
11	29.98	9.77	13.01	9.97	3.03	.250	.599	123.1	133.7	546.0	542.0	540.5	3.005	.9799	1.305	.0822	.1987	1.086
12	29.88	9.33	13.03	9.99	3.02	.137	.609	122.4	132.2	546.0	542.0	541.5	2.989	.9339	1.304	.0452	.2009	1.08
								Primary-nozzle position, open										
13	30.12	13.01	10.00	9.98	5.89	0.577	0.0647	257.0	250.3	540.5	541.0	538.0	3.018	1.304	1.002	0.0980	0.0111	1.056
14	30.02	13.05	10.11	10.03	5.89	.581	.1298	255.5	248.8	542.5	545.5	541.5	2.993	1.301	1.008	.1005	.0220	1.057
15	29.87	13.05	10.03	10.01	5.89	.589	.0784	255.0	249.6	542.0	545.5	542.0	2.984	1.304	1.002	.1003	.0130	1.062
16	30.12	13.03	10.21	10.01	5.88	.589	.1961	256.8	251.0	542.0	547.0	543.5	3.009	1.302	1.020	.1006	.0333	1.080
17	29.92	13.04	10.39	10.01	5.87	.590	.2476	254.8	249.6	542.5	547.0	544.0	2.989	1.303	1.037	.1009	.0422	1.064
18	29.97	13.03	10.62	9.99	5.82	.589	.3060	255.2	251.0	541.0	547.0	544.5	3.000	1.304	1.063	.1017	.0526	1.057
19	30.02	13.01	11.17	10.0	5.85	.588	.3991	255.8	254.8	541.0	547.0	544.0	3.002	1.301	1.117	.1010	.0684	1.090
20	30.12	13.05	13.06	10.01	5.87	.589	.6270	258.8	263.1	541.3	547.5	544.0	3.009	1.304	1.305	.1009	.1070	1.111
21	30.04	9.86	12.95	9.97	5.84	.255	.651	256.1	248.9	546.0	542.0	544.0	3.013	.9890	1.299	.0435	.1113	1.054
22	30.09	10.49	13.00	9.96	5.84	.304	.647	256.8	251.0	546.0	544.0	548.0	3.015	1.051	1.303	.0520	.1108	1.081
23	30.09	11.10	13.00	9.98	5.85	.368	.641	256.8	253.1	546.0	544.5	548.0	3.015	1.112	1.303	.0628	.1098	1.069
24	30.09	11.81	13.00	9.99	5.86	.448	.631	256.5	255.7	546.5	548.0	547.0	3.012	1.182	1.301	.0765	.1077	1.086
25	30.09	12.35	13.00	9.98	5.84	.507	.626	256.6	257.4	547.0	547.0	547.6	3.015	1.237	1.303	.0868	.1072	1.088
26	30.14	13.04	13.00	9.98	5.80	.587	.617	257.2	260.9	547.0	549.0	548.0	3.020	1.307	1.305	.1014	.1065	1.100
27	30.14	13.46	13.01	9.99	5.85	.651	.612	257.0	262.4	547.0	549.5	548.0	3.017	1.346	1.302	.1115	.1047	1.107

[a] Values obtained from nozzle calibration.

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TABLE IV - EJECTOR PERFORMANCE

Run	Primary-stream total pressure P_p (in. mercury absolute)	Secondary-stream total pressure P_s (in. mercury absolute)	Tertiary-stream total pressure P_t (in. mercury absolute)	Ambient exhaust pressure p_0 (in. mercury absolute)	Primary weight flow W_p (lb/sec)	Secondary weight flow W_s (lb/sec)	Tertiary weight flow W_t (lb/sec)	Gross thrust of primary nozzle with shrouds removed F_j (lb) (a)	Gross thrust of ejector F_{ej} (lb)	Primary-stream total temperature T_p (°R)	Secondary-stream total temperature T_s (°R)	Tertiary-stream total temperature T_t (°R)	Primary pressure ratio P_p/p_0	Secondary pressure ratio P_s/p_0	Tertiary pressure ratio P_t/p_0	Secondary weight-flow ratio $\frac{W_s}{W_p}\sqrt{\frac{T_s}{T_p}}$	Tertiary weight-flow ratio $\frac{W_t}{W_p}\sqrt{\frac{T_t}{T_p}}$	Gross-thrust ratio F_{ej}/F_j
Primary-nozzle position, closed																		
1	30.07	27.18	27.20	27.18	1.68	0.143	0.087	20.89	22.75	536.0	539.5	539.5	1.106	1.000	1.001	0.0864	0.0580	1.089
2	30.28	27.42	27.42	27.38	1.67	.207	.144	20.89	21.35	547.0	540.5	541.5	1.104	1.001	1.001	.1233	.0858	1.036
3	30.07	27.36	27.37	27.29	1.68	.249	.181	20.06	20.82	548.0	541.5	543.0	1.102	1.003	1.003	.1485	.1086	1.027
4	30.09	27.40	27.40	27.28	1.68	.288	.221	19.80	21.35	548.0	542.0	544.5	1.100	1.004	1.004	.1714	.1327	1.088
5	29.97	27.47	27.47	27.27	1.68	.335	.266	19.15	22.04	548.5	543.5	545.0	1.098	1.007	1.007	.1986	.1579	1.151
6	29.97	27.61	27.61	27.30	1.64	.402	.326	19.18	21.33	549.0	544.0	546.8	1.098	1.011	1.011	.2440	.1983	1.113
7	29.97	27.86	27.89	27.30	1.68	.524	.430	19.15	24.89	549.8	545.5	547.5	1.098	1.021	1.022	.3108	.2555	1.289
8	29.97	28.08	28.11	27.28	1.68	.648	.507	19.12	25.80	549.5	547.0	548.5	1.098	1.030	1.031	.3858	.3015	1.339
9	29.97	20.04	20.08	20.02	2.67	.181	.078	66.91	73.94	549.0	546.0	546.5	1.497	1.001	1.000	.0601	.0291	1.105
10	29.92	20.06	20.04	20.0	2.67	.204	.131	66.85	73.24	549.0	548.0	548.5	1.496	1.003	1.002	.0782	.0480	1.108
11	29.92	20.15	20.12	19.99	2.66	.272	.200	66.41	72.82	549.0	548.5	548.5	1.492	1.007	1.007	.1021	.0750	1.092
12	29.97	20.27	20.26	20.03	2.66	.337	.270	66.96	74.66	549.0	548.5	548.5	1.496	1.012	1.012	.1264	.1013	1.116
13	29.87	20.37	20.37	19.97	2.70	.396	.326	66.75	73.94	549.5	548.5	547.0	1.496	1.020	1.020	.1462	.1204	1.108
14	29.87	21.11	21.15	19.98	2.70	.630	.525	66.82	78.92	549.5	548.0	548.0	1.496	1.059	1.059	.2360	.1954	1.181
15	30.12	20.22	20.24	20.02	2.71	.312	.242	67.90	73.96	549.5	548.0	548.0	1.504	1.010	1.011	.1149	.0892	1.089
16	30.09	20.06	19.97	19.97	2.63	.149	.060	66.43	74.66	547.0	541.0	542.0	1.507	1.005	1.000	.0564	.0227	1.091
17	29.99	15.08	14.98	14.98	2.91	.139	.070	96.89	103.1	549.0	542.5	544.0	2.002	1.005	1.000	.0475	.0240	1.064
18	30.09	15.10	15.07	14.99	2.92	.204	.132	97.46	103.6	550.0	543.0	544.5	2.007	1.007	1.005	.0695	.0450	1.065
19	29.89	15.13	15.12	14.98	2.92	.235	.167	96.14	104.6	550.5	544.0	546.0	1.996	1.010	1.009	.0793	.0570	1.067
20	30.09	15.27	15.27	15.03	2.94	.287	.227	97.14	105.2	551.0	545.0	547.0	2.002	1.016	1.016	.0971	.0769	1.065
21	29.79	15.35	15.32	14.96	2.92	.334	.269	96.81	104.5	551.5	546.0	548.0	1.988	1.026	1.026	.1141	.0918	1.065
22	30.14	15.50	15.40	14.96	2.93	.391	.323	97.19	106.7	550.0	547.0	549.0	2.015	1.036	1.034	.1336	.1099	1.069
23	30.14	16.34	16.34	15.01	2.95	.554	.468	97.64	111.6	548.5	549.0	550.0	2.008	1.090	1.088	.1886	.1643	1.143
24	30.28	9.95	9.96	9.93	3.00	.132	.045	124.9	128.7	554.0	550.5	549.0	3.047	1.002	1.002	.0439	.0216	1.030
25	30.06	10.04	10.04	9.94	3.01	.173	.101	125.7	127.3	554.0	550.5	550.0	3.024	1.010	1.010	.0573	.0335	1.029
26	29.96	10.15	10.17	9.98	2.97	.211	.154	122.9	128.7	554.0	551.0	550.0	2.999	1.018	1.018	.0708	.0517	1.047
27	30.11	10.33	10.33	9.98	3.00	.268	.211	123.9	128.7	555.0	552.0	551.0	3.017	1.035	1.035	.0891	.0700	1.039
28	29.96	10.53	10.53	9.99	2.99	.318	.262	122.9	128.7	555.0	552.0	552.0	2.995	1.054	1.054	.1064	.0894	1.047
29	29.86	10.80	10.80	10.03	2.99	.363	.309	122.7	130.8	555.0	552.5	552.0	2.987	1.077	1.077	.1211	.1030	1.066
30	30.11	11.32	11.32	10.08	3.00	.435	.391	123.5	135.0	555.5	553.0	552.0	2.995	1.126	1.125	.1450	.1299	1.077
31	30.01	12.24	12.22	9.98	3.00	.527	.515	123.3	134.4	556.0	554.0	552.0	3.007	1.228	1.224	.1756	.1712	1.080
32	40.06	10.00	9.99	10.00	4.00	.159	.066	180.1	184.1	556.5	553.5	552.0	4.006	1.000	.9990	.0397	.0159	1.022
33	40.06	10.12	10.10	9.98	4.00	.213	.130	180.3	184.1	555.5	553.5	552.8	4.014	1.014	1.012	.0532	.0324	1.021
34	40.11	10.24	10.24	10.0	4.01	.258	.185	180.5	186.3	555.5	553.5	552.0	4.011	1.024	1.024	.0642	.0460	1.032
35	40.21	10.34	10.34	9.99	4.03	.297	.233	181.0	187.7	556.0	554.0	552.5	4.026	1.035	1.035	.0738	.0578	1.037
36	40.51	10.59	10.58	9.93	4.06	.367	.304	183.1	189.1	555.0	554.0	552.0	4.080	1.066	1.066	.0903	.0747	1.033
37	40.36	11.09	11.08	9.98	4.08	.435	.380	181.4	188.3	556.0	554.0	552.0	4.034	1.111	1.111	.1061	.0942	1.027
38	39.96	12.71	12.71	10.02	4.01	.641	.571	179.6	189.8	554.5	554.5	551.5	3.988	1.268	1.268	.1599	.1420	1.057
39	60.46	9.70	9.70	9.98	6.06	.272	0	286.9	288.6	555.0	554.0	546.0	6.056	.9718	.9718	.0449	0	1.009
40	61.06	9.89	9.89	9.97	6.14	.290	.086	290.4	301.5	554.5	554.0	551.5	6.124	.9920	.9920	.0472	.0140	1.007
41	60.31	10.06	10.06	10.02	6.06	.304	.129	290.0	292.5	554.0	554.0	551.5	6.019	1.003	1.003	.0500	.0212	1.006
42	60.26	10.23	10.23	10.07	6.07	.329	.182	294.5	295.6	554.0	555.5	551.5	5.984	1.016	1.016	.0542	.0299	1.005
43	60.66	10.27	10.27	9.99	6.10	.359	.234	297.0	297.8	554.0	555.5	551.0	6.072	1.028	1.026	.0589	.0383	1.003
44	60.32	10.26	10.24	10.00	6.06	.358	.224	295.2	292.9	552.0	545.0	543.5	6.035	1.026	1.024	.0587	.0367	.9928
45	60.60	11.01	11.00	9.97	6.11	.442	.348	295.2	300.0	552.0	546.0	545.0	6.066	1.104	1.103	.0719	.0595	1.013
46	60.15	12.08	12.06	9.98	6.05	.529	.495	294.3	302.2	552.0	547.5	546.5	6.034	1.215	1.211	.0869	.0819	1.027
47	60.10	13.85	13.85	10.0	6.04	.619	.654	295.9	319.1	552.5	548.0	547.0	6.010	1.385	1.385	.1021	.1078	1.082
48	80.85	8.46	8.44	9.98	8.10	.166	0	410.2	394.6	553.5	548.0	539.0	8.081	.8477	.8457	.0190	0	.9618
49	80.70	9.57	9.57	10.01	8.11	.243	.079	410.6	401.6	553.5	548.5	547.0	8.062	.9560	.9560	.0299	.0096	.9783
50	80.80	10.08	10.08	10.06	8.10	.280	.152	409.6	408.1	553.5	549.0	547.5	7.986	1.000	1.000	.0345	.0187	.9959
51	80.40	10.24	10.25	10.06	8.06	.292	.200	408.4	408.7	554.0	550.0	549.0	7.992	1.018	1.017	.0362	.0247	.9959
52	80.40	10.52	10.35	10.09	8.05	.318	.260	408.4	408.1	554.5	551.0	549.5	7.968	1.043	1.048	.0395	.0310	.9992
53	80.70	10.92	10.91	10.03	8.07	.355	.309	410.2	418.9	556.0	551.0	550.0	8.046	1.089	1.086	.0438	.0381	1.014
54	80.63	11.46	11.45	9.95	8.09	.401	.341	409.4	417.4	554.0	548.0	545.0	8.093	1.152	1.151	.0483	.0488	1.019
55	80.48	12.56	12.38	10.03	8.05	.475	.475	409.6	425.9	554.0	550.0	547.0	8.094	1.252	1.232	.0586	.0584	1.040
56	80.58	14.45	14.41	9.97	8.07	.614	.650	410.0	440.8	554.0	550.0	548.0	8.089	1.449	1.448	.0758	.0801	1.075
57	80.33	13.19	13.19	10.02	8.08	.534	.547	408.5	430.2	554.0	551.0	548.0	8.017	1.318	1.316	.0661	.0676	1.053
58	84.83	8.48	8.48	8.62	8.48	.140	.102	436.4	432.5	554.0	550.0	548.0	9.836	.9815	.9815	.0164	.0120	.9869
59	84.73	8.73	8.73	8.84	8.49	.160	.131	436.7	435.6	554.0	550.0	548.0	9.585	.9876	.9876	.0187	.0153	.9835
60	84.58	9.41	9.41	8.85	8.46	.214	.226	438.1	439.4	554.0	550.0	548.0	9.557	1.063	1.063	.0262	.0268	1.005
61	84.88	9.98	9.98	8.85	8.48	.261	.266	438.4	447.2	554.0	550.0	549.0	9.590	1.130	1.130	.0307	.0336	1.020
62	84.38	10.77	10.76	8.84	8.48	.328	.359	436.8	450.8	555.0	551.0	549.0	9.545	1.218	1.217	.0387	.0423	1.032
63	84.63	11.57	11.57	8.86	8.50	.393	.431	438.0	449.4	554.0	551.0	549.0	9.530	1.303	1.303	.0461	.0502	1.026
64	84.38	12.18	12.18	8.83	8.47	.441	.482	437.3	462.2	555.0	552.0	549.0	9.556	1.378	1.377	.0520	.0568	1.057
65	84.43	13.17	13.13	8.82	8.47	.516	.566	437.2	470.0	555.0	552.0	549.0	9.573	1.493	1.488	.0607	.0652	1.075
66	84.83	14.48	14.40	8.86	8.48	.590	.650	438.1	480.6	555.0	552.0	550.0	9.552	1.628	1.625	.0706	.0765	1.097
67	84.73	6.80	6.78	8.86	8.51	.035	.024	438.9	418.8	555.0	551.0	544.0	9.563	.7675	.7652	.0041	.0028	.9641
68	84.48	7.56	7.41	8.85	8.48	.044	.042	437.4	422.5	556.0	551.0	548.0	9.546	.8506	.8373	.0075	.0050	.9656
69	84.23	7.88	7.89	8.84	8.46	.095	.062	436.2	427.3	556.0	551.0	547.0	9.528	.8926	.8926	.0111	.0072	.9797
70	80.58	8.89	8.82	9.88	8.08	.192	.025	410.0	401.7	556.0	551.0	545.0	8.090	.8926	.8956	.0237	.0031	.9797
71	80.53	8.77	8.80	9.87	8.08	.182	.017	410.0	401.0	556.0	551.0	545.0	8.077	.8796	.8926	.0226	.0021	.9760

[a]Values obtained from nozzle calibration.

TABLE IV - Concluded. EJECTOR PERFORMANCE

Run	Primary-stream total pressure P_p (in. mercury absolute)	Secondary-stream total pressure P_s (in. mercury absolute)	Tertiary-stream total pressure P_t (in. mercury absolute)	Ambient exhaust pressure p_0 (in. mercury absolute)	Primary weight flow W_p (lb/sec)	Secondary weight flow W_s (lb/sec)	Tertiary weight flow W_t (lb/sec)	Gross thrust of primary nozzle with shrouds removed F_j (lb) (a)	Gross thrust of ejector F_{ej} (lb)	Primary-stream total temperature T_p (°R)	Secondary-stream total temperature T_s (°R)	Tertiary-stream total temperature T_t (°R)	Primary pressure ratio P_p/p_0	Secondary pressure ratio P_s/p_0	Tertiary pressure ratio P_t/p_0	Secondary weight flow ratio $\frac{W_s}{W_p}\sqrt{\frac{T_s}{T_p}}$	Tertiary weight flow ratio $\frac{W_t}{W_p}\sqrt{\frac{T_t}{T_p}}$	Gross-thrust ratio F_{ej}/F_j
								Primary-nozzle position, open										
1	30.19	27.08	27.08	27.12	3.60	0.250	0	52.54	46.2	553.0	549.0	548.0	1.113	0.9989	0.9985	0.0692	0	0.8793
2	30.19	27.19	27.20	27.16	3.54	.305	.129	56.57	48.5	553.0	549.5	549.5	1.112	1.001	1.001	.0859	.0343	.8638
3	30.04	27.19	27.17	27.10	3.48	.343	.164	50.88	44.6	554.0	550.0	551.0	1.108	1.003	1.003	.0982	.0482	.8839
4	30.24	27.31	27.31	27.18	3.53	.394	.224	52.71	46.9	554.5	551.0	552.0	1.113	1.005	1.005	.1112	.0634	.8897
5	30.08	27.32	27.32	27.10	3.50	.434	.264	51.34	47.6	555.0	552.0	553.0	1.110	1.008	1.008	.1237	.0753	.9828
6	30.09	27.46	27.46	27.14	3.51	.506	.331	50.54	46.3	555.5	552.0	554.0	1.109	1.013	1.013	.1457	.0942	.9600
7	29.99	27.64	27.64	27.10	3.50	.607	.417	49.76	50.5	555.6	553.5	554.5	1.107	1.020	1.020	.1751	.1190	1.015
8	29.99	19.91	19.91	20.0	5.84	.344	0	241.7	237.2	549.0	549.0	548.0	1.500	.9955	.9955	.0621	0	.9814
9	30.19	20.04	20.04	20.0	5.58	.398	.131	144.4	140.1	550.0	550.0	549.0	1.510	1.002	1.002	.0717	.0238	.9704
10	30.14	20.11	20.11	20.02	5.55	.438	.182	143.1	140.8	550.0	551.0	550.0	1.505	1.004	1.004	.0786	.0326	.9838
11	30.04	20.15	20.14	19.94	5.53	.494	.241	143.3	142.2	551.0	552.0	552.0	1.507	1.011	1.010	.0894	.0436	.9928
12	30.09	20.38	20.38	20.01	5.56	.588	.318	143.2	143.6	551.0	552.0	552.0	1.504	1.018	1.018	.1091	.0583	1.003
13	30.04	20.58	20.58	20.0	5.54	.635	.387	142.4	145.9	551.0	553.0	553.0	1.502	1.029	1.030	.1148	.0700	1.024
14	30.04	20.96	20.96	20.01	5.55	.730	.448	141.8	150.0	551.0	553.0	554.0	1.501	1.047	1.047	.1318	.0861	1.056
15	29.98	21.63	21.64	20.0	5.52	.889	.638	141.7	154.3	552.0	553.0	554.0	1.500	1.082	1.082	.1615	.1147	1.089
16	29.98	14.90	14.89	15.01	5.80	.312	0	193.6	181.3	550.0	553.0	550.0	1.998	.9927	.9920	.0539	0	.9378
17	30.14	15.09	15.10	15.06	5.83	.355	.107	194.6	194.6	550.0	554.0	552.0	2.001	1.002	1.003	.0607	.0184	1.00
18	30.04	15.11	15.10	14.99	5.86	.401	.164	194.4	193.4	550.0	554.0	553.0	2.004	1.008	1.007	.0687	.0285	.9948
19	30.14	15.28	15.25	15.03	5.84	.472	.238	194.9	198.4	551.0	554.0	553.0	2.005	1.015	1.015	.0810	.0403	1.018
20	30.14	15.58	15.57	15.03	5.88	.568	.324	194.9	201.9	551.0	555.0	554.0	2.008	1.035	1.036	.0974	.0558	1.036
21	30.14	15.80	15.79	15.02	5.84	.625	.381	198.3	201.9	551.0	555.0	554.0	2.007	1.052	1.051	.1070	.0653	1.034
22	30.24	16.42	16.42	15.01	5.86	.842	.542	196.8	211.9	550.0	555.0	554.0	2.015	1.094	1.094	.1443	.0877	1.077
23	30.14	17.34	17.37	14.94	5.88	1.077	.680	196.2	223.3	550.0	556.0	554.0	2.017	1.154	1.158	.1850	.1151	1.138
24	30.04	16.16	16.15	14.98	5.85	.721	.456	194.2	205.5	550.0	556.0	554.0	2.005	1.079	1.077	.1243	.0801	1.058
25	30.07	9.79	9.79	9.99	5.84	.232	0	238.3	238.9	548.0	544.5	539.5	3.010	.9780	.9800	.0396	0	1.011
26	30.02	10.09	10.10	10.02	5.82	.260	.150	235.4	240.5	548.0	548.0	544.0	2.996	1.007	1.008	.0446	.0252	1.020
27	30.12	10.19	10.20	10.03	5.82	.271	.197	236.6	240.3	548.0	548.0	546.0	3.003	1.016	1.017	.0465	.0337	1.016
28	30.02	10.41	10.41	10.02	5.83	.297	.266	235.6	241.0	549.0	547.5	547.5	2.996	1.039	1.039	.0506	.0455	1.023
29	30.19	10.73	10.73	10.01	5.85	.328	.329	236.8	244.6	549.0	548.0	548.0	3.009	1.072	1.072	.0559	.0563	1.033
30	29.92	11.39	11.39	10.02	5.83	.402	.434	234.5	248.1	549.0	549.0	548.5	2.986	1.137	1.137	.0690	.0744	1.058
31	30.07	12.15	12.15	10.01	5.86	.483	.527	235.9	256.0	549.5	550.0	549.0	3.003	1.214	1.214	.0826	.0901	1.085
32	30.08	13.38	13.40	10.01	5.82	.639	.650	236.8	265.2	549.5	551.0	550.0	2.998	1.337	1.339	.1097	.1117	1.128
33	40.22	9.83	9.82	10.0	7.79	.082	0	347.3	343.4	552.0	550.0	541.5	4.022	.983	.982	.0105	0	.9886
34	40.07	10.11	10.10	10.03	7.80	.108	.156	345.5	344.3	551.0	551.0	550.0	3.996	1.008	1.007	.0138	.0199	1.005
35	40.19	10.37	10.37	10.0	7.81	.123	.261	346.0	346.3	551.0	551.0	551.0	4.019	1.037	1.037	.0157	.0334	1.001
36	40.18	10.67	10.66	10.01	7.81	.136	.297	344.3	349.1	555.0	551.0	551.0	4.011	1.066	1.064	.0174	.0379	1.008
37	40.26	11.06	11.06	10.01	7.81	.166	.379	347.0	351.2	555.0	551.0	551.0	4.021	1.104	1.104	.0213	.0484	1.012
38	40.20	11.69	11.68	10.02	7.78	.212	.480	346.5	356.2	553.0	552.0	552.0	4.012	1.167	1.166	.0272	.0620	1.028
39	40.08	12.33	12.32	9.99	7.77	.258	.621	345.2	358.3	553.0	552.0	552.0	4.009	1.234	1.234	.0332	.0870	1.036
40	40.20	13.69	13.71	10.02	7.77	.396	.645	346.6	371.9	553.0	552.0	552.0	4.012	1.366	1.368	.0510	.0829	1.073
41	40.20	13.04	13.04	10.01	7.78	.327	.593	348.4	366.9	552.0	552.0	552.0	4.016	1.303	1.303	.0420	.0761	1.056
42	40.15	12.69	12.70	10.03	7.80	.297	.562	348.0	364.0	552.0	552.0	552.0	4.003	1.265	1.266	.0381	.0721	1.049
43	40.20	12.24	12.28	10.00	7.81	.259	.525	347.0	361.9	552.0	553.0	552.0	4.020	1.224	1.228	.0332	.0670	1.043
44	40.20	13.28	13.30	10.02	7.82	.347	.611	346.8	369.7	551.0	554.0	552.0	4.012	1.325	1.327	.0445	.0782	1.067
45	55.30	9.43	9.44	9.16	10.78	0	.178	519.6	515.8	551.0	553.0	551.0	6.037	1.029	1.031	0	.0164	.9925
46	55.54	10.27	10.28	9.16	10.77	.022	.275	522.3	523.3	551.0	552.0	551.0	6.061	1.119	1.121	.0020	.0255	1.002
47	55.25	10.67	10.66	9.15	10.76	.032	.318	518.8	521.9	551.0	552.0	551.0	6.038	1.166	1.167	.0030	.0296	1.006
48	55.30	11.42	11.46	9.17	10.77	.052	.391	519.3	527.6	551.0	552.0	551.0	6.031	1.245	1.249	.0048	.0363	1.016
49	55.50	12.40	12.40	9.18	10.74	.081	.476	521.7	536.8	550.0	552.0	551.0	6.046	1.351	1.351	.0075	.0442	1.029
50	55.15	12.88	12.82	9.17	10.75	.101	.513	517.5	536.1	550.0	552.0	551.0	6.014	1.401	1.398	.0094	.0477	1.036
51	55.30	13.88	13.91	9.17	10.75	.154	.601	519.5	546.8	550.0	553.0	551.0	6.031	1.514	1.517	.0143	.0560	1.053
52	55.30	14.70	14.74	9.17	10.72	.206	.667	518.7	552.4	550.0	553.0	552.0	6.031	1.603	1.607	.0191	.0625	1.063
53	55.18	9.34	9.39	5.81	10.76	0	.298	548.0	563.8	546.0	548.0	541.0	9.497	1.614	1.616	0	.0287	1.027
54	55.18	10.29	10.32	5.80	10.75	.022	.348	548.3	567.4	546.0	546.0	543.0	9.514	1.782	1.782	.0021	.0331	1.033
55	55.18	10.87	10.86	5.80	10.74	.038	.394	548.9	573.1	546.0	546.0	545.0	9.514	1.874	1.871	.0036	.0367	1.044
56	55.23	11.71	11.70	5.81	10.77	.062	.461	549.7	579.8	546.0	546.0	544.0	9.506	2.015	2.014	.0058	.0426	1.053
57	55.13	12.67	12.63	5.80	10.72	.098	.522	548.7	584.4	546.0	546.0	544.0	9.505	2.184	2.180	.0091	.0487	1.065
58	55.18	12.65	12.61	5.81	10.71	.096	.529	549.0	585.2	548.0	548.0	544.0	9.497	2.177	2.170	.0090	.0494	1.066
59	55.25	13.60	13.61	5.80	10.72	.146	.605	549.6	591.6	548.0	548.0	546.0	9.522	2.348	2.347	.0136	.0563	1.076
60	55.23	14.30	14.49	5.81	10.71	.197	.687	549.6	598.7	548.0	547.0	547.0	9.506	2.496	2.494	.0184	.0626	1.089
61	55.35	9.39	9.37	6.85	10.76	0	.274	540.4	548.9	547.0	548.0	547.0	8.077	1.371	1.368	0	.0255	1.015
62	55.31	10.31	10.27	6.85	10.69	.026	.342	539.2	553.2	547.0	547.0	547.0	8.048	1.505	1.499	.0025	.0320	1.026
63	55.28	10.85	10.84	6.85	10.72	.038	.387	540.3	558.1	547.0	547.0	547.0	8.070	1.584	1.582	.0035	.0361	1.033
64	55.28	11.54	11.55	6.86	10.76	.067	.445	540.4	563.1	547.0	547.0	547.0	8.058	1.685	1.684	.0062	.0412	1.042
65	55.19	12.69	12.68	6.86	10.71	.096	.529	539.2	571.6	547.0	547.0	547.0	8.055	1.853	1.851	.0092	.0494	1.060
66	54.98	13.46	13.45	6.85	10.66	.136	.586	537.6	575.2	546.0	546.0	546.0	8.026	1.965	1.961	.0129	.0551	1.070
67	55.06	14.42	14.42	6.86	10.65	.189	.661	538.3	583.0	546.5	547.0	547.0	8.029	2.102	2.102	.0180	.0618	1.083

[a]Values obtained from nozzle calibration.

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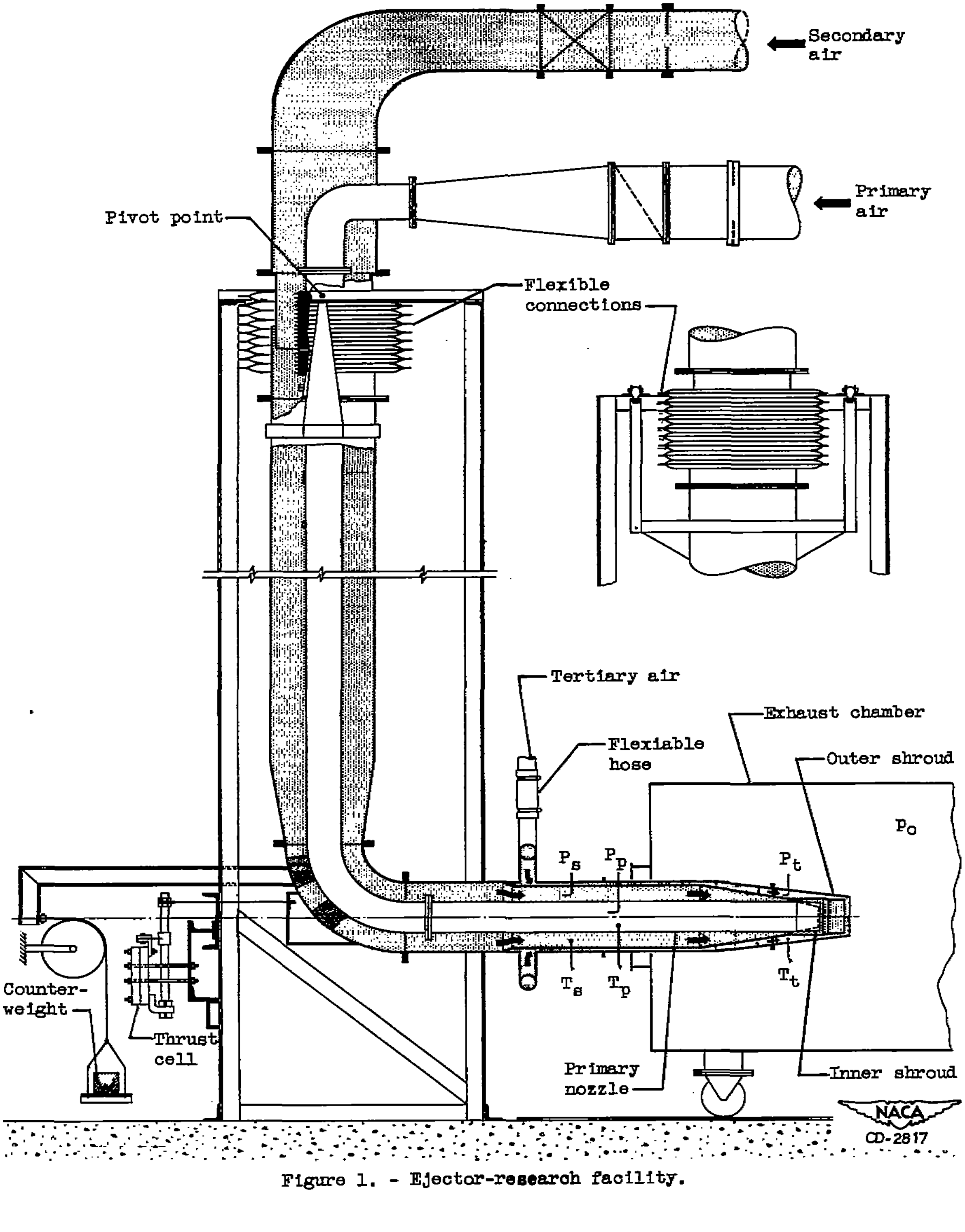

Figure 1. - Ejector-research facility.

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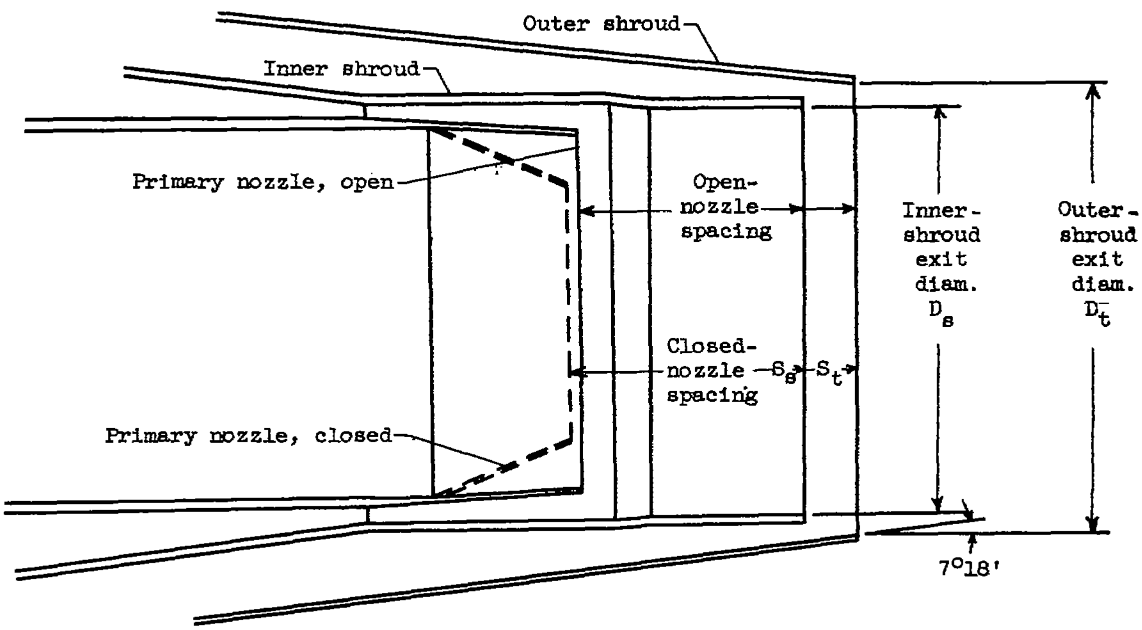
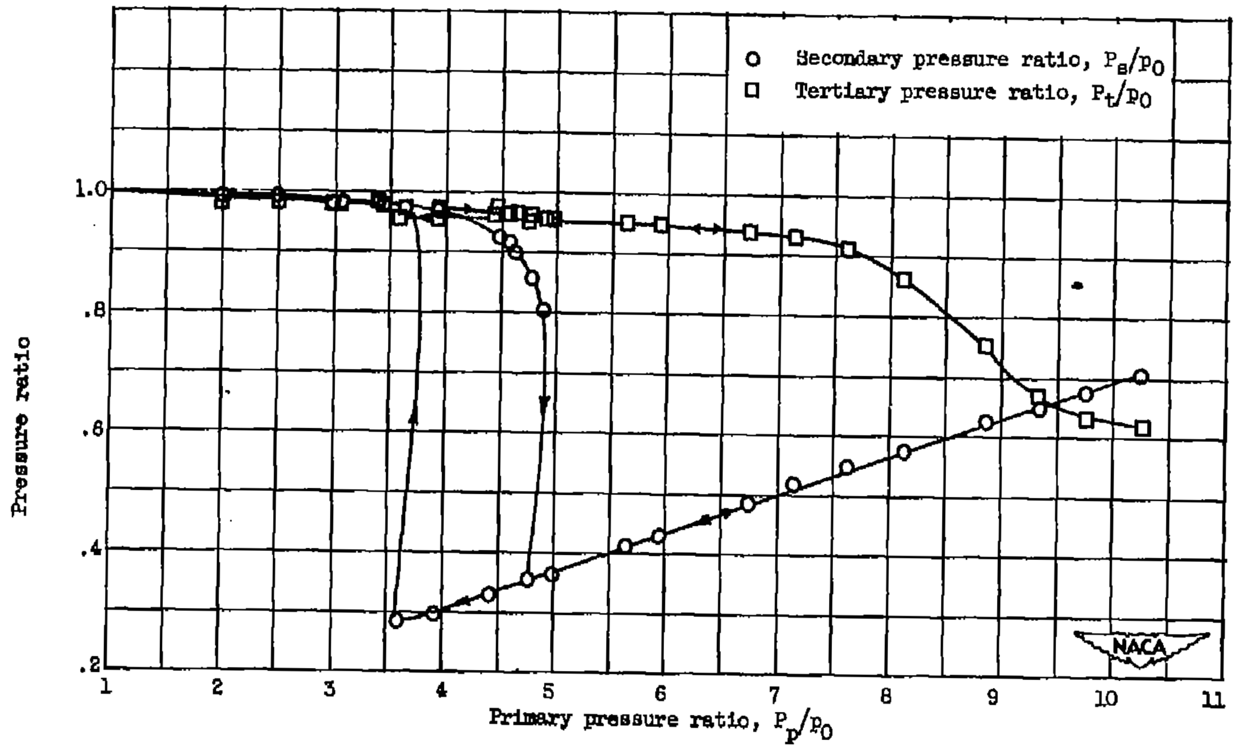


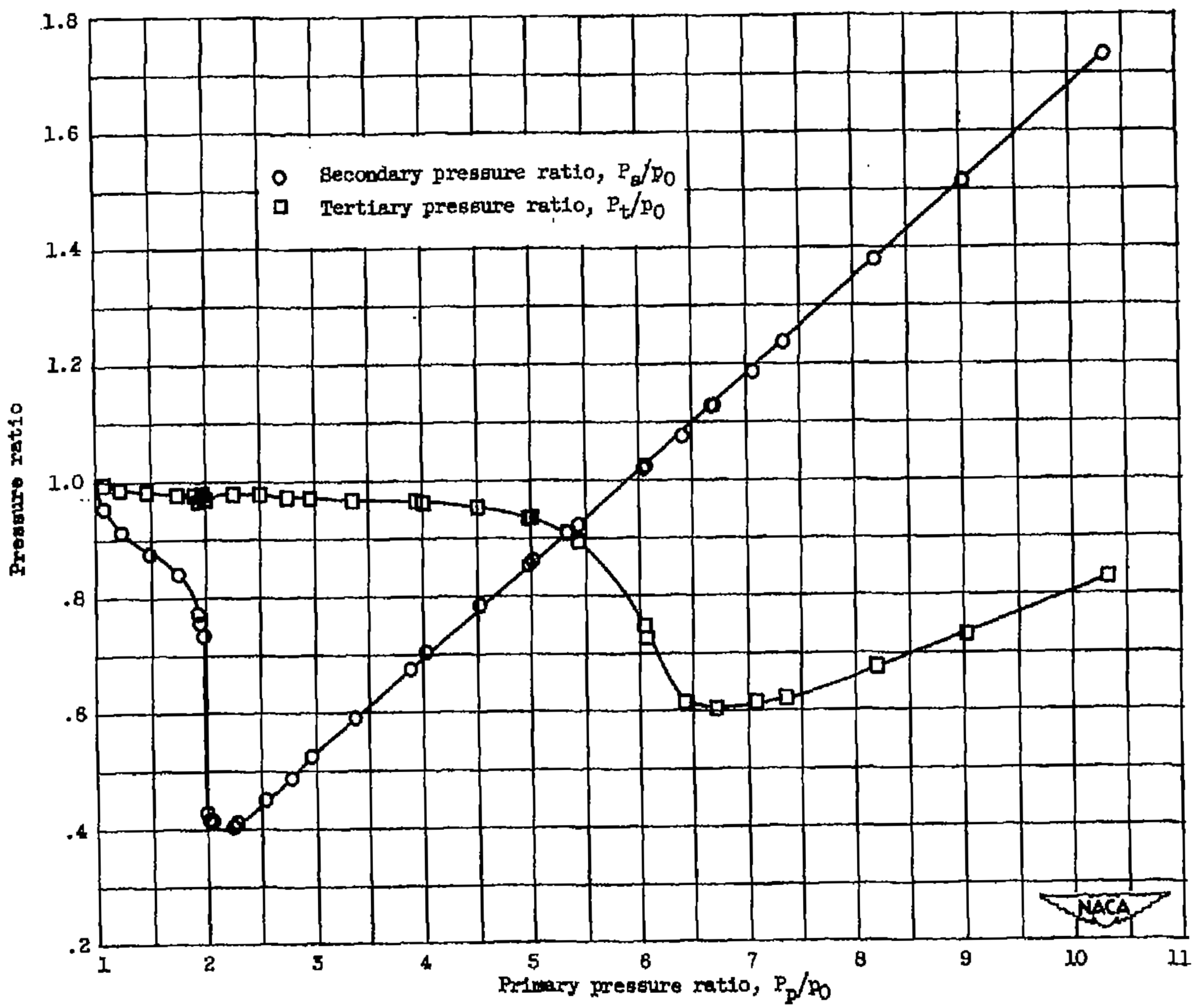
Nozzle position	D_p (in.)	D_s/D_p	S_s/D_p	D_t/D_p	S_t/D_p	D_t/D_s	S_t/D_s
Open	4.79	1.18	0.59	1.32	0.75	1.12	0.635
Closed	3.49	1.62	.86	1.80	1.07	1.12	.663

Figure 2. - Ejector notation and description of ejector models.



(a) Primary-nozzle position, closed.

Figure 3. - Double-shroud ejector performance. Zero cooling-air flow.



(b) Primary-nozzle position, open.

Figure 3. - Concluded. Double-shroud ejector performance. Zero cooling-air flow.

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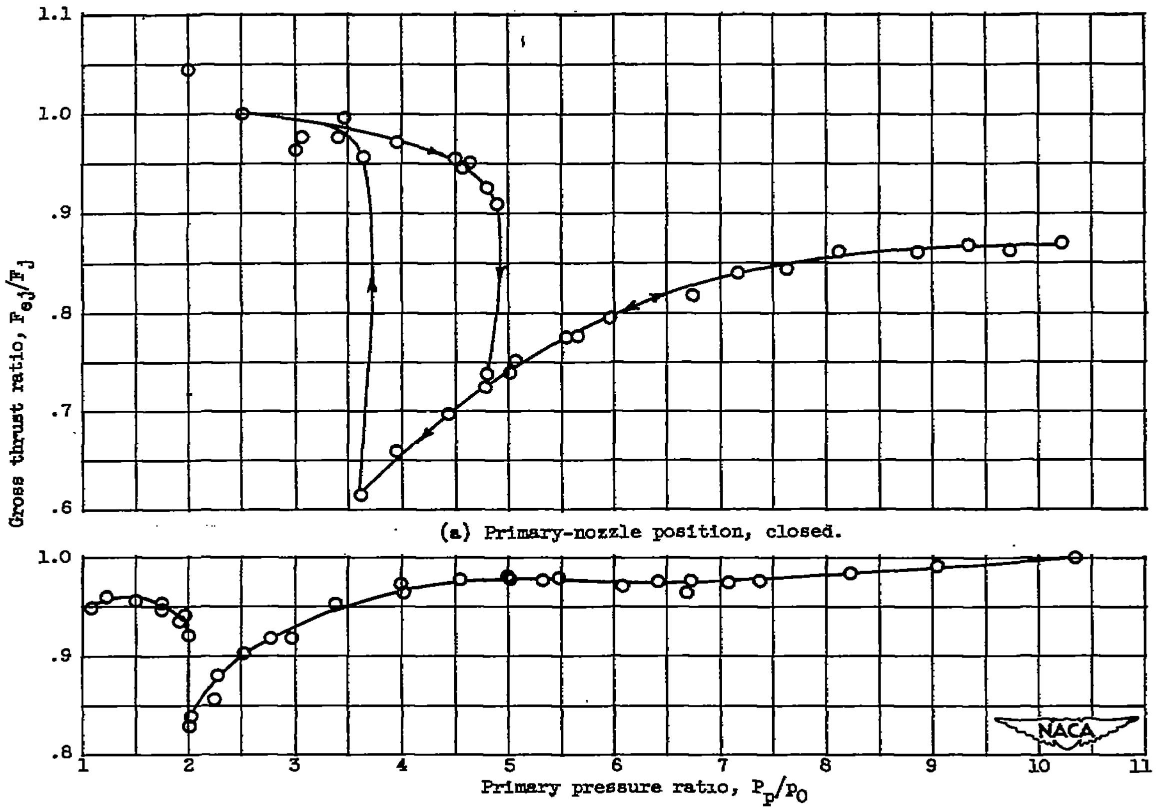
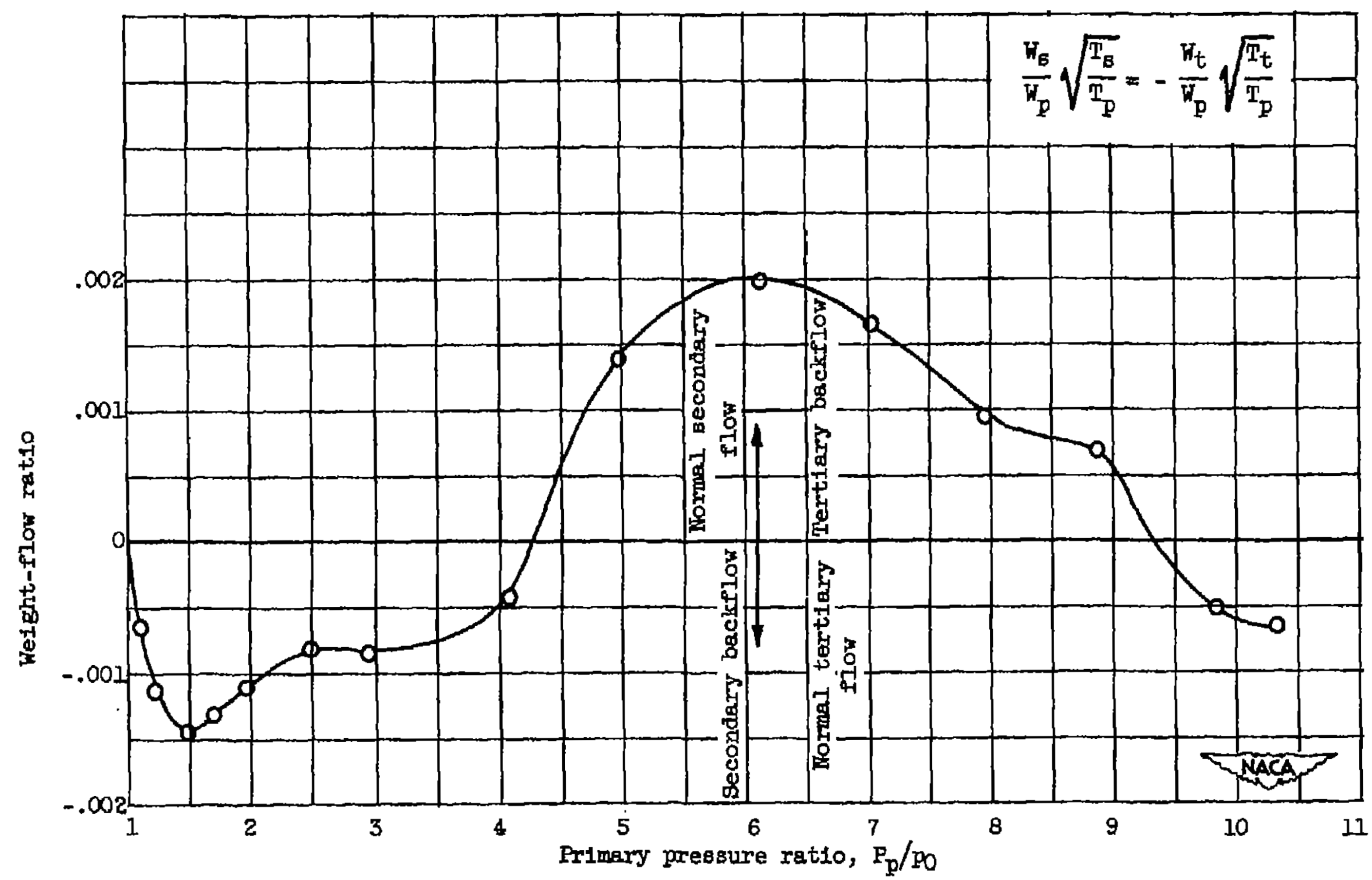


(a) Primary-nozzle position, closed.

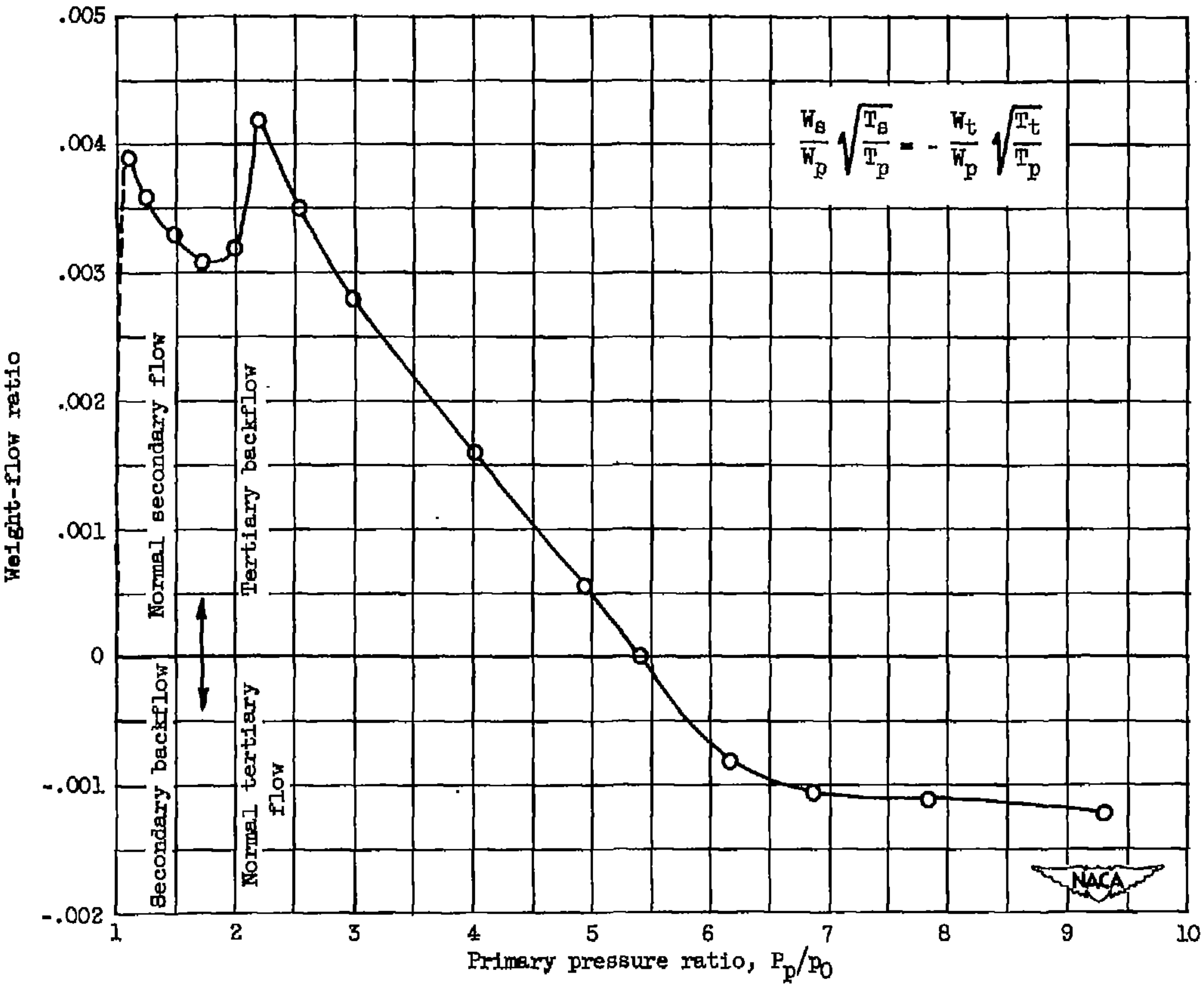
(b) Primary-nozzle position, open.

Figure 4. - Effect of primary pressure ratio on gross thrust ratio. Zero cooling-air flow.



(a) Primary-nozzle position, closed.

Figure 5. - Effect of primary pressure ratio on backflow.



(b) Primary-nozzle position, open.

Figure 5. - Concluded. Effect of primary pressure ratio on backflow.

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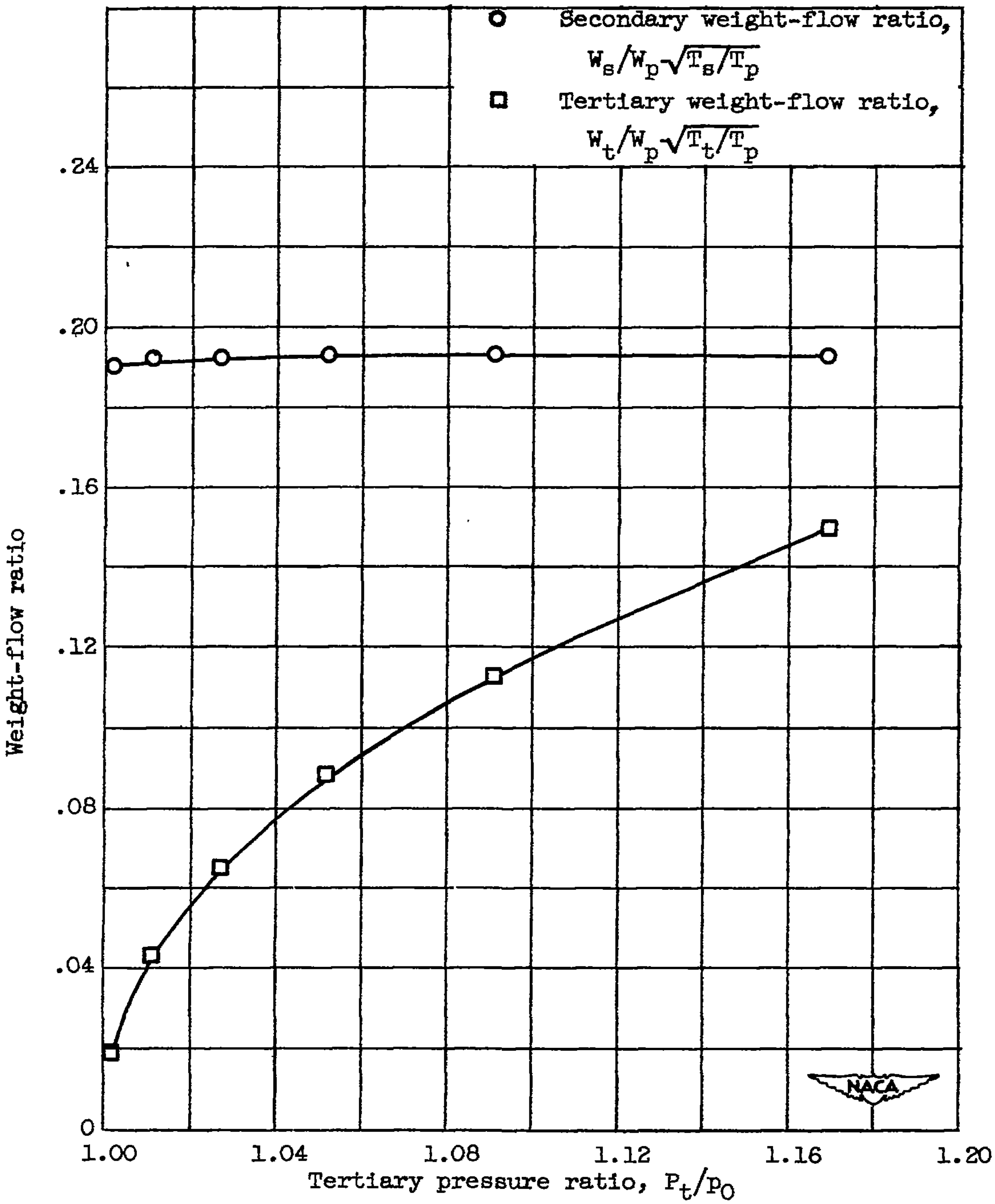

Figure 6. - Effect of tertiary pressure ratio on secondary and tertiary weight-flow ratios with primary nozzle in closed position. Primary pressure ratio, P_p/p_0, 2.99; secondary pressure ratio, P_s/p_0, 1.302.

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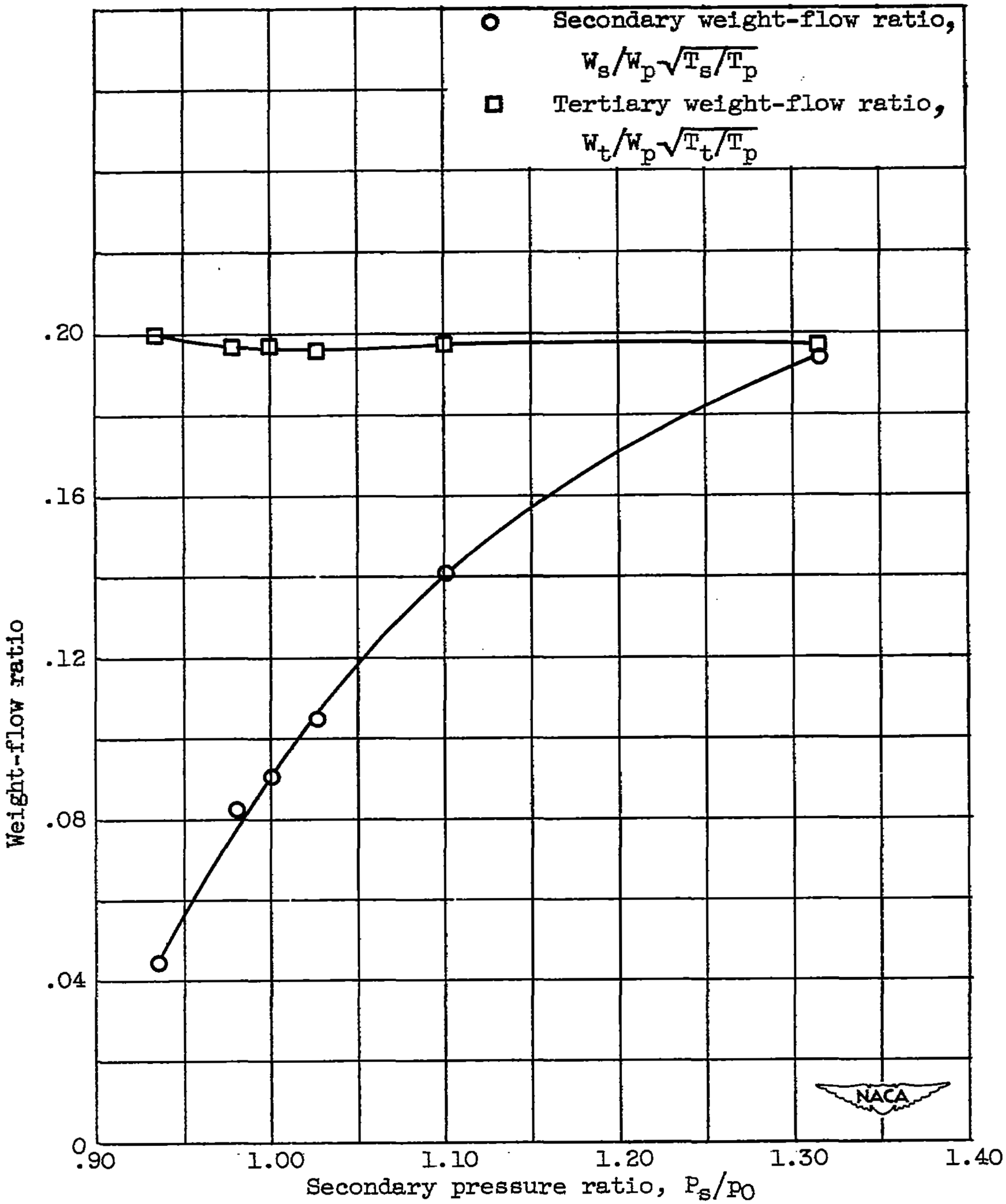

Figure 7. - Effect of secondary pressure ratio on secondary and tertiary weight-flow ratios with primary nozzle in closed position. Primary pressure ratio, P_p/p_0, 2.99; tertiary pressure ratio, P_t/p_0, 1.304.

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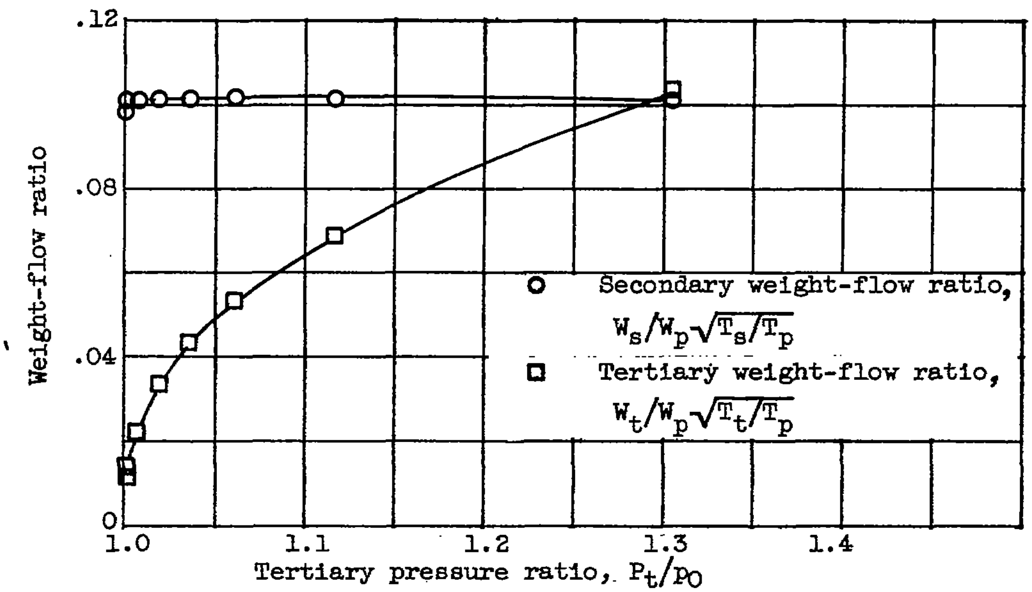

Figure 8. - Effect of tertiary pressure ratio on secondary and tertiary weight-flow ratios with primary nozzle in open position. Primary pressure ratio, P_p/p_0, 3.0; secondary pressure ratio, P_s/p_0, 1.304.

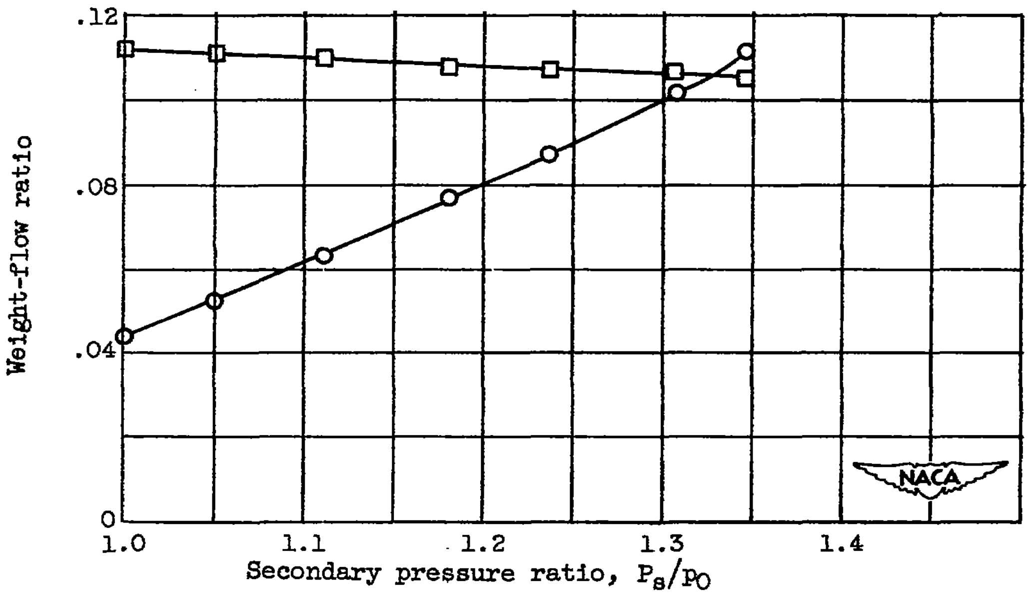

Figure 9. - Effect of secondary pressure ratio on secondary and tertiary weight-flow ratios with primary nozzle in open position. Primary pressure ratio, P_p/p_0, 3.015; secondary pressure ratio, P_s/p_0, 1.303.

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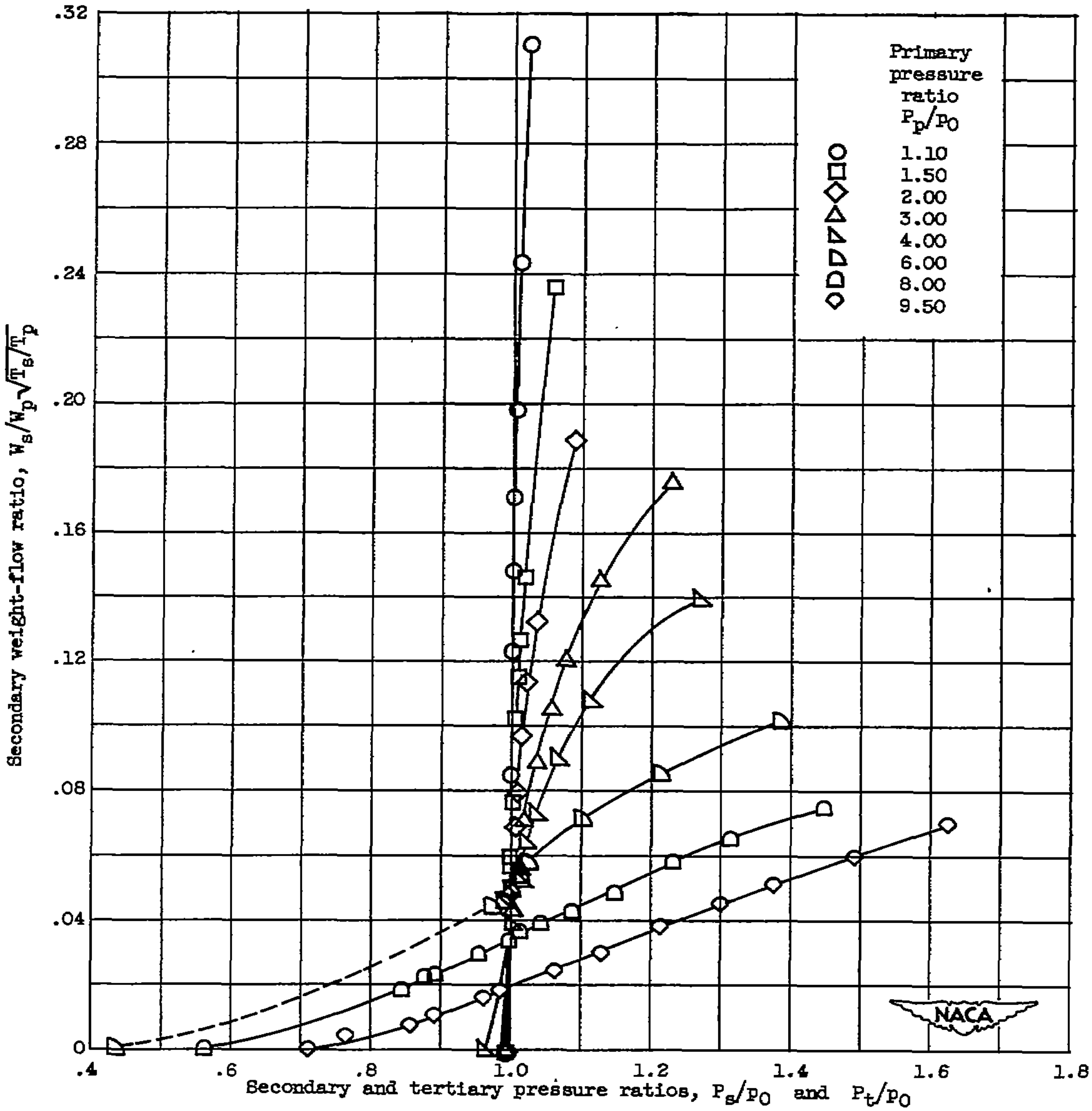

(a) Effect of secondary and tertiary pressure ratios on secondary weight-flow ratio.

Figure 10. - Double-shroud ejector pumping characteristics with primary nozzle in closed position.

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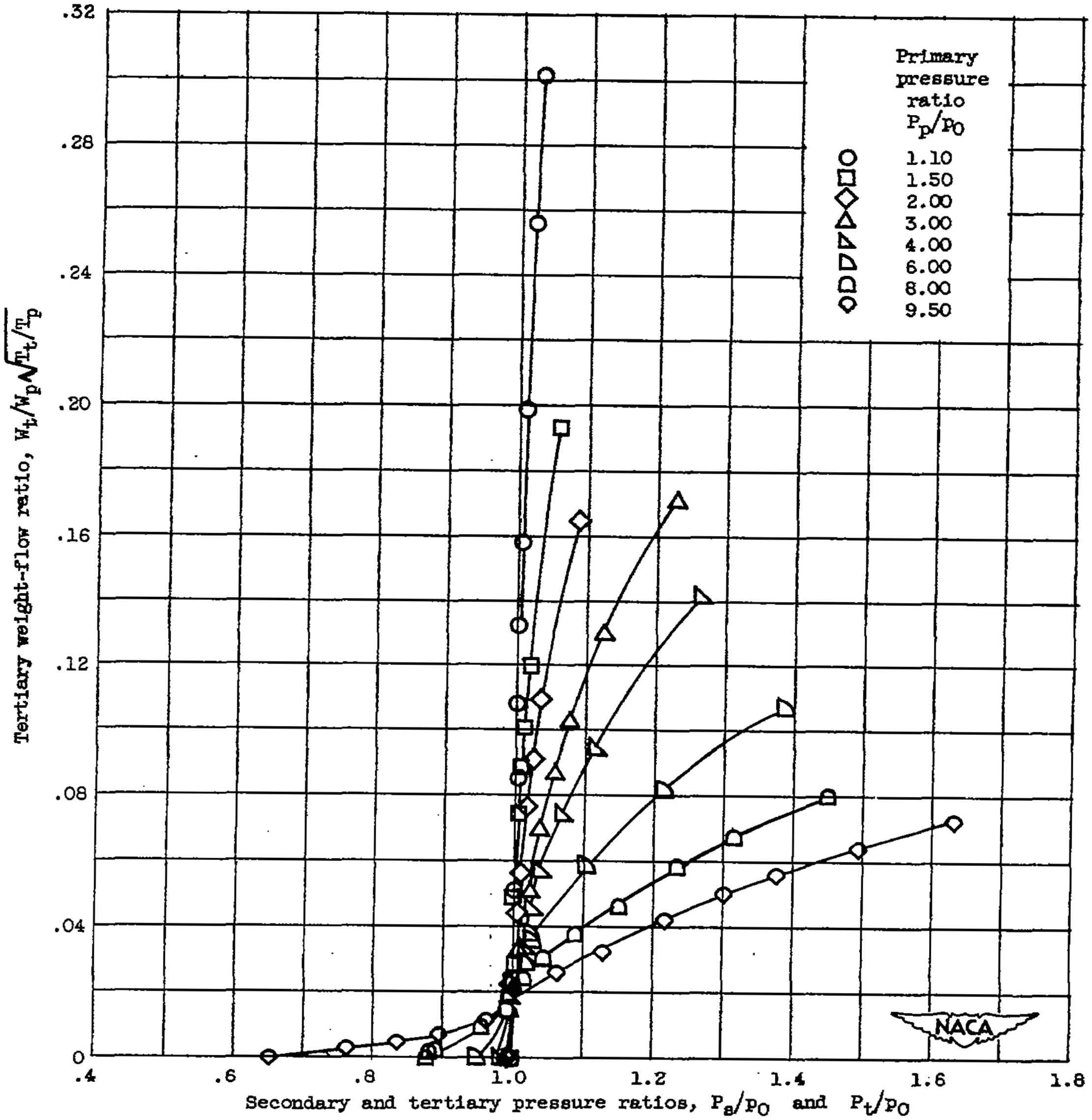

(b) Effect of secondary and tertiary pressure ratios on tertiary weight-flow ratio.

Figure 10. - Concluded. Double-shroud ejector pumping characteristics with primary nozzle in closed position.

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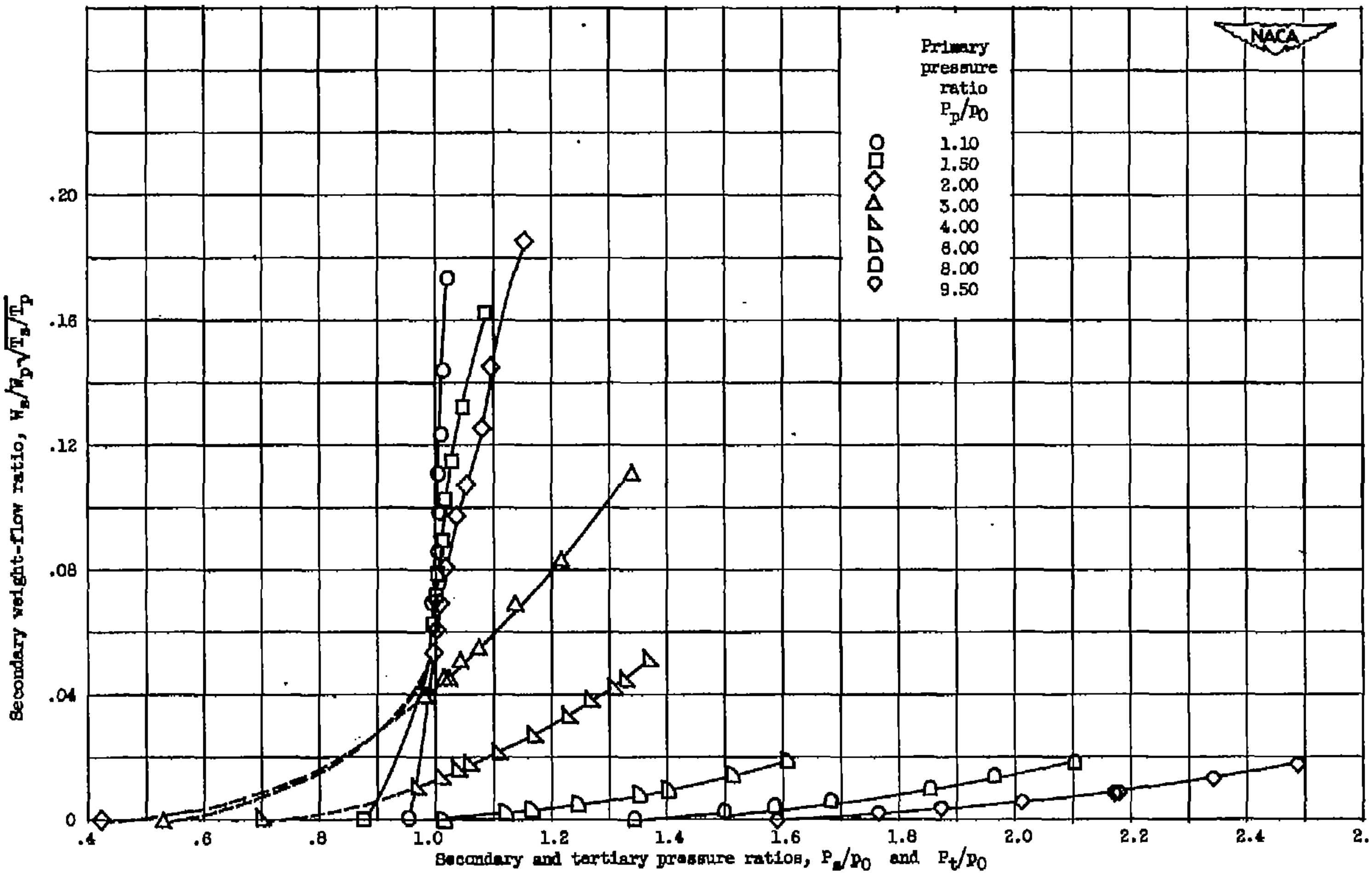
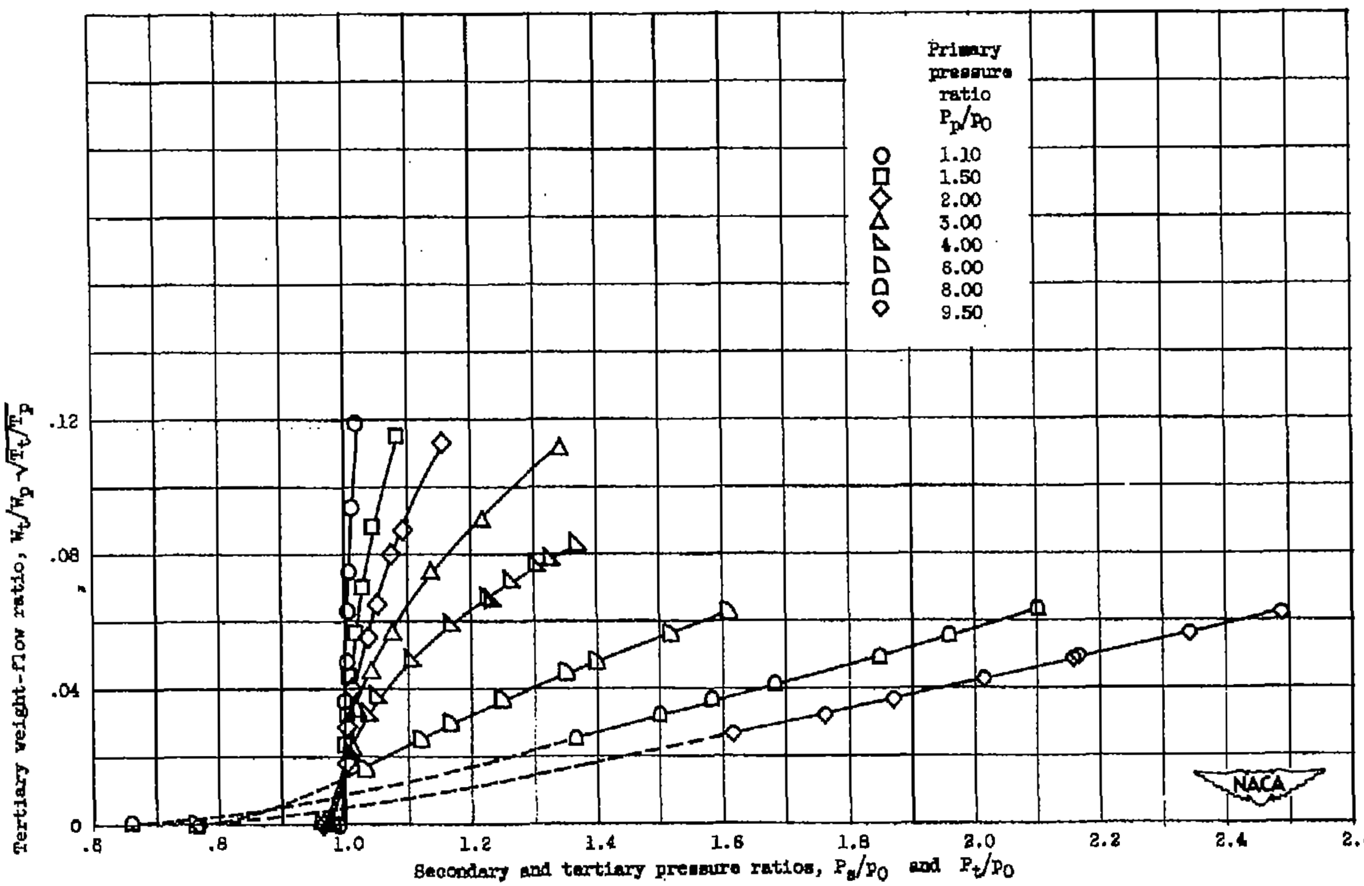


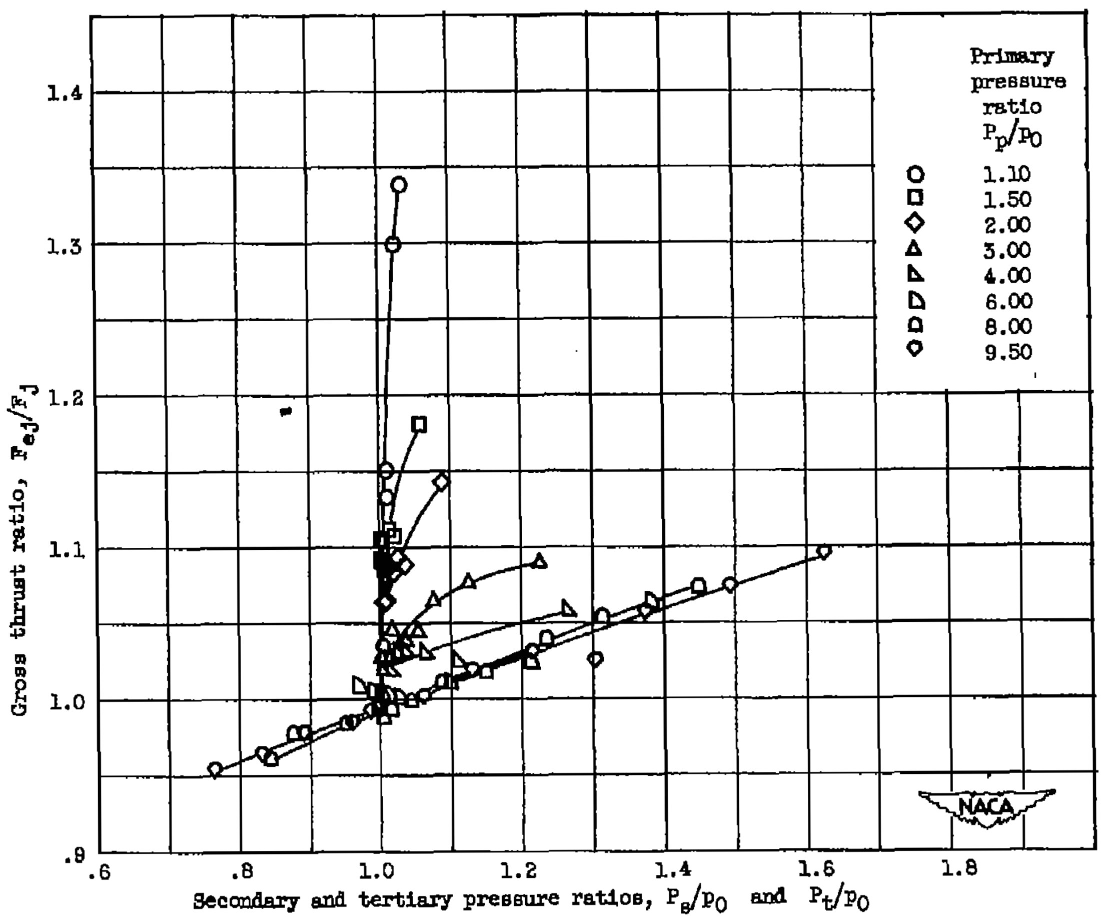
(a) Effect of secondary and tertiary pressure ratios on secondary weight-flow ratio.

Figure 11. - Ejector pumping characteristics with primary nozzle in open position.



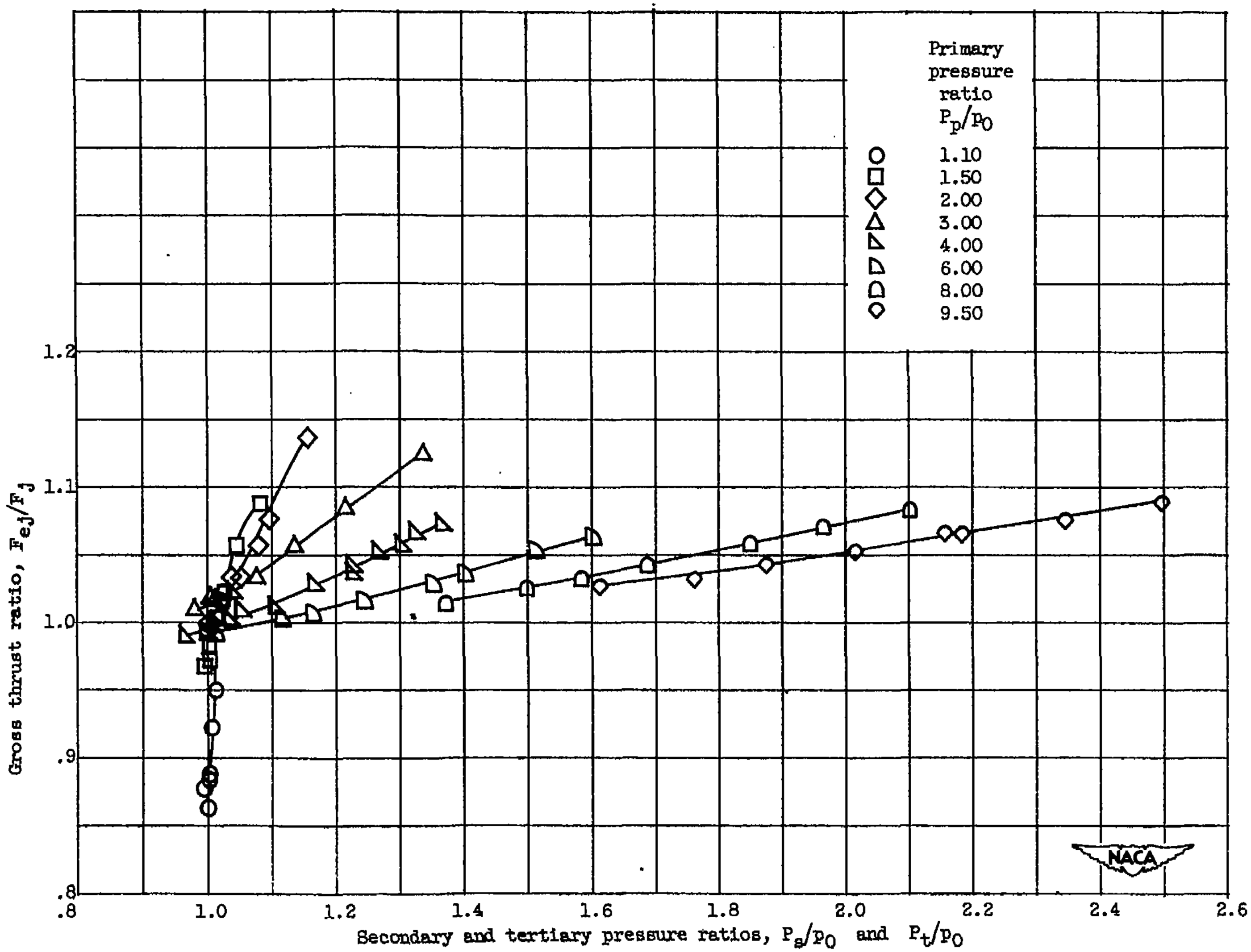
(b) Effect of secondary and tertiary pressure ratios on tertiary weight-flow ratio.

Figure 11. - Concluded. Ejector pumping characteristics with primary nozzle in open position.



(a) Primary-nozzle position, closed.

Figure 12. - Double-shroud ejector thrust characteristics.



(b) Primary-nozzle position, open.

Figure 12. - Concluded. Double-shroud ejector thrust characteristics.

SECURITY INFORMATION

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