RESEARCH MEMORANDUM

PRELIMINARY PERFORMANCE DATA FOR THE J57-P-1 TURBOJET ENGINE AT ALTITUDES UP TO 65,000 FEET

By Robert R. Miller and Harry E. Bloomer

Lewis Flight Propulsion Laboratory
Cleveland, Ohio

Bureau of Aeronautics, Department of the Navy

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
WASHINGTON
PRELIMINARY PERFORMANCE DATA FOR THE J57-P-1 TURBOJET
ENGINE AT ALTITUDES UP TO 65,000 FEET
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SUMMARY

An investigation to determine the high altitude performance (ex-
tending the range of ref. 1) of the J57-P-1 turbojet engine and compo-
nents was conducted at the NACA Lewis altitude wind tunnel. Data were
obtained over a corrected inboard rotor speed range from 106 to 79 per-
cent of rated speed, with four modes of engine operation, at altitudes
from 35,000 to 65,000 feet and at a flight Mach number of 0.81. The
corresponding range of Reynolds number indices was from 0.437 to 0.107.

All engine and component parameters are presented as functions of
corrected rotor speed except the data with the automatic engine control;
these data are plotted against altitude.

INTRODUCTION

At the request of the Navy Department, Bureau of Aeronautics, an in-
vestigation of the J57-P-1 turbojet engine performance was made in the
altitude wind tunnel at the NACA Lewis laboratory. Data obtained with
a fixed-area exhaust nozzle up to an altitude of 50,000 feet are pre-
sented in reference 1; limitations of the test facility prevented opera-
tion at higher altitudes. By installing no-flow ejectors at the engine
exhaust nozzle and bleed ports it was possible to extend the range of
simulated altitudes to an altitude of 65,000 feet. The engine perfor-
ance data for this extended altitude operation are presented herein.

Data were obtained with a fixed-area exhaust nozzle over a range of
corrected inboard rotor speeds from 106 to 79 percent of rated speed at
altitudes from 35,000 to 65,000 feet, at a flight Mach number of 0.81.
The corresponding range of Reynolds number indices varied from 0.437
to 0.107.
All engine and component parameters are presented as functions of corrected rotor speed with the exception of the automatic control data and ideal jet thrust. Ideal jet thrust $F_{j,i}$ is plotted as a function of exhaust nozzle pressure drop parameter, $1.25 P_9 - P_0$; and the automatic control data are presented to show the variation in performance parameters with changes in altitude.

At low rotor speeds, to avoid compressor surge during normal engine operation, a portion of the engine air flow is bled overboard.

Four modes of engine operation were investigated, each over a range of engine speeds and altitudes. The modes are as follows:

(a) Engine operation with both the compressor bleed ports closed.

(b) Engine operation with the large compressor bleed port open.

(c) Engine operation with both compressor bleed ports open.

(d) Normal engine operation with the automatic control.

ENGINE INSTALLATION AND INSTRUMENTATION

Engine

A cross-sectional view of the J57-P-1 turbojet engine is shown in figure 1. The engine is equipped with two compressor bleeds, one large and one small, which bleed engine air from between the compressors at low rotor speeds to prevent surge. The bleeds operate in sequence according to a schedule based on outboard rotor speed and engine inlet temperature. For additional information concerning the engine, consult references 1 and 2.

Instrumentation

The location of the instrumentation stations is shown in the cross-sectional view of the engine, figure 1. In addition, a table is included indicating the amount of instrumentation at each station.

PROCEDURE

Performance data were obtained, at a flight Mach number of 0.81, at altitudes from 35,000 to 65,000 feet by the installation of no-secondary flow ejectors at the exhaust nozzle outlet and at the outlet of the
compressor bleed ports. (See ref. 3 for details and performance of no-flow ejectors.) The no-flow ejectors made possible high altitude operation over an inboard rotor speed range of 7000 to 9500 rpm except where limited by compressor surge, over-temperature operation of the turbine, or minimum fuel flow (approximately 200 lb/hr, a minimum allowable setting of test facility fuel control throttle).

Data were obtained defining four modes of engine operation. With the automatic control in operation data were taken with engine throttle settings of "idle" and "maximum," and altitude was increased from 35,000 feet to the altitude at which compressor surge occurred, for each throttle setting.

For further details regarding PROCEDURE, see reference 1.

PRESENTATION OF RESULTS

The figures are grouped according to the dependent variable and an index to the figures is presented in table I. The figures are presented in the same order as in reference 1. In each figure group for a given dependent variable, four modes of engine operation are presented. The modes and corresponding figure parts are as follows:

(a) Engine operation with both the compressor bleed ports closed.
(b) Engine operation with the large compressor bleed port open.
(c) Engine operation with both compressor bleed ports open.
(d) Normal engine operation with the automatic control.

Dashed curves denote 15,000 foot performance data taken from reference 1, and are shown for all conditions for which 15,000 foot data were obtained. The break in the 15,000 foot line is the region of compressor surge at that altitude. All solid symbols represent either the upper or lower boundary of compressor surge as indicated in each particular figure key. Turbine outlet temperature limits, as indicated by the four manufacturer's probes, is denoted with cross marks near the high speed end of the figures.

Complete compressor surge and operational information for the four modes of engine operation described in this report can be found in reference 2.

A tabulation of the data is presented in table II.
Over-all engine performance is presented in figures 2 to 9. Compressor performance is presented in figures 10 to 16. Combustor performance is shown in figure 17 and turbine performance in figure 18.

The data presented herein show some effect of engine deterioration when compared to reference 1, and it should be pointed out that over 120 engine hours were logged between these sets of data. In addition a small difference in compressor bleed air flow exists and is attributed to a change in configuration of the bleed port exit ducting which was installed to facilitate this air flow measurement.

Lewis Flight Propulsion Laboratory
National Advisory Committee for Aeronautics
Cleveland, Ohio, October 29, 1954
The following symbols are used in this report:

- $F_J$: jet thrust, lb
- $F_{J,i}$: ideal jet thrust lb, calculated from pressure and temperatures at the exhaust nozzle inlet, lb
- $F_n$: net thrust, lb
- $g$: acceleration due to gravity, 32.2 ft/sec^2
- $M$: Mach number
- $N$: rotor speed, rpm
- $P$: total pressure, lb/sq ft
- $p$: static pressure, lb/sq ft
- $R$: gas constant, (ft-lb)/(lb °R)
- $T$: total temperature, °R
- $t$: static temperature, °R
- $V$: velocity, ft/sec
- $W_a$: air flow, lb/sec
- $W_f$: fuel flow, lb/hr
- $W_g$: gas flow, lb/sec
- $\gamma$: ratio of specific heats

$$\gamma = \frac{\gamma_4}{Y_4^{\gamma_4 - 1}}$$

$$\beta = \frac{\left(\frac{\gamma_4 + 1}{2}\right)^{\gamma_4 - 1}}{\gamma_4}$$

$\beta$ function of $\gamma$, $\gamma^* = 1.4$

- $\epsilon$: ratio of absolute total pressure in engine to absolute static pressure of NACA standard atmosphere at sea level
\[ \eta \] efficiency
\[ \rho \] density, slugs/cu ft
\[ \theta \] ratio of absolute total temperature in engine to absolute static temperature of NACA standard atmosphere at sea level
\[ \theta_{cr} = \frac{\gamma^* T^*}{\gamma + 1} \cdot \frac{\gamma^* + 1}{T^* \gamma^*}, \text{ where } \gamma^* = 1.4, T^* = 519^\circ \text{ R} \]
\[ \phi \] ratio of absolute viscosity of air in engine to the absolute viscosity of air of NACA standard atmosphere at sea level
\[ \frac{5}{\bar{\theta}} \phi \] Reynolds number index

Subscripts:
- a air
- b combustor
- c compressor
- cr critical
- i ideal
- in inboard
- out outboard
- t turbine
- 0 altitude test condition
- 1 outboard compressor inlet
- 2 inboard compressor inlet
- 3 inboard compressor discharge
- 4 inboard turbine inlet
- 5 outboard turbine inlet
outboard turbine discharge

exhaust nozzle inlet

REFERENCES


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Over-all Engine Performance

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Outboard Compressor Performance

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Over-all Compressor Performance

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Over-all Turbine Performance

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\textsuperscript{a}The "(a)" part of figures 2 to 19 has altitude as the independent variable (abscissa).
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TABLE II. - PRELIMINARY ALTITUDE PERFORMANCE DATA OF THE J57-P-1 TURBOJET ENGINE
{**Chain of Thought**

1. The document contains a table with various data entries.
2. The table is related to engine performance, as indicated by the presence of columns for 'Engine', 'Pressure', 'Speed', and 'Temperature'.
3. The data appears to be organized in a structured manner, typical of scientific or technical reports.
4. The table includes numerical values, which are crucial for understanding the performance metrics.

**Question:** What is the primary focus of the table in the document?

**Answer:** The primary focus of the table is to provide data related to engine performance, specifically concerning pressure, speed, and temperature.
**TABLE II.** - Concluded. PRELIMINARY ALTITUDE PERFORMANCE DATA OF THE J57-P-1 TURBOJET ENGINE

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*Engine operation with both the compressor bleed ports closed.*
<table>
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<tr>
<th>Run</th>
<th>Blown, Wbored, &amp; Air flow</th>
<th>Entrainment</th>
<th>Wf, lb/sec</th>
<th>Fuel flow, lb/sec</th>
<th>Specific fuel consumption</th>
<th>Exhaust-gas total temperature</th>
<th>Compressor pressure, psig</th>
<th>Compressor efficiency, %</th>
<th>Combined corrected</th>
<th>Combined corrected</th>
<th>Turbine corrected</th>
<th>Thrust transferred, hp (1,000 psfpb)</th>
<th>Combustor corrected</th>
<th>Combustor corrected, %</th>
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Engine operation with both compressor bleed ports open.
Figure 1. - Cross-section of J57-P-1 turbojet engine showing location of instrumentation.
Figure 2. The variation of corrected outboard rotor speed, \(\frac{N_{\text{out}}}{\sqrt{M_1}}\), rpm, with corrected inboard rotor speed over a range of flight Mach numbers 0.81.
At rotor speeds lower than those indicated by the solid points, compressor surge is encountered and no steady-state operation is possible.

Cross marks indicate limiting turbine outlet temperature.

--- Dashed lines indicate 15,000 feet data from reference 1.
Figure 2. - The variation of corrected outboard rotor speed with corrected inboard rotor speed over a range of altitude and flight Mach number 0.81.
Altitude, ft.
- 46,000
- 49,000
- 51,000
- 53,000
- 56,000
- 62,000
- 65,000

- At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.

Cross marks indicate limiting turbine outlet temperature.

Corrected outboard rotor speed, \(N_{\text{out}}/\sqrt{h}\), rpm

With the large compressor bleed port open.

Corrected inboard rotor speed, \(N_{\text{in}}/\sqrt{h}\), rpm

Graphical representation of corrected outboard rotor speed over a range of altitudes.
Figure 2 - The variation of corrected outboard rotor speed over a range of flight Mach number 0.81.

Corrected outboard rotor speed, $\frac{N_{out}}{\sqrt{\gamma E_1}}$, rpm
ion with both compressor bleed ports open.

of corrected outboard rotor speed
tor speed over a range of altitudes.

Altitude, ft.
- 44,000
- 45,000
- 46,000
- 50,000
- 51,000
- 52,000
- 56,000
- 62,000
- 65,000

--- Dashed lines indicate
15,000 feet data from
reference 1.

- At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.

Cross marks indicate limiting turbine outlet temperature.
Figure 2. - The variation of corrected rotor speed with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.
Figure 3. The variation of corrected air flow with corrected outboard rotor speed over a range of altitudes. Flight Mach number 0.81.
(b) Engine operation with the large compressor bleed port open.

Figure 3 - The variation of corrected air flow with corrected outboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 3. - The variation of corrected air flow with corrected outboard rotor speed over a range of altitudes. Flight Mach number 0.81.

At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.

Cross marks indicate limiting turbine outlet temperature.

---

Atmosphere

- Dashed lines indicate 15,000 feet data from reference 1.

- Engine operation with both compressor bleed ports open.
(d) Engine operation with the automatic control.

Figure 3. - The variation of corrected air flow with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.
Figure 4. - The variation of corrected fuel flow with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 4. - The variation of corrected fuel flow with corrected inboard rotor speed over a range of altitudes.

Flight Mach number 0.81.

At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.

Cross marks indicate limiting turbine outlet temperature.
Engine operation with both compressor bleed ports open.

Figure 4. - The variation of corrected fuel flow with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 4. - The variation of corrected fuel flow with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.
Figure 5. - The variation of corrected exhaust-gas total temperature with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 5. The variation of corrected exhaust-gas total temperature with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.

At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal. Cross marks indicate limiting turbine outlet temperature.
Figure 5. - The variation of corrected exhaust-gas total temperature with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.

<table>
<thead>
<tr>
<th>Altitude, ft.</th>
<th>Corrected exhaust-gas total temperature, ( \frac{t_{eg}}{t_{a}} ), deg. C</th>
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<td>65,000</td>
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- Dashed lines indicate 15,000 ft data from reference 1.

At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal. Cross marks indicate limiting turbine outlet temperature.
Figure 5. - The variation of corrected exhaust-gas total temperature with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.

(d) Engine operation with the automatic control.
Altitude, ft.
- 46,000
- 49,000
- 51,000
- 53,000
- 55,000
- 58,000
- 62,000
- 65,000

--- Dashed lines indicate 15,000 ft data from reference 1.
- At rotor speeds lower than those indicated by the solid points, compressor surge is encountered and no steady-state operation is possible. Cross marks indicate limiting turbine outlet temperature.

Corrected inboard rotor speed, $m_{1p}/\rho_{1}$, rpm

(a) Engine operation with both compressor bleed ports closed.

Figure 6. - The variation of engine total pressure ratio with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.

Cross marks indicate limiting turbine outlet temperature.

(b) Engine operation with the large compressor bleed port open.

Figure 6. - The variation of engine total pressure ratio with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 6. - The variation of engine total pressure ratio
with corrected inboard rotor speed over a range of altitudes.
Flight Mach number 0.81.
Figure 6. - The variation of engine total pressure ratio with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.
Figure 7. - The variation of corrected net thrust with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal. Cross marks indicate limiting turbine outlet temperature.

Figure 7. - The variation of corrected net thrust with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 7. The variation of corrected net thrust with corrected inboard rotor speed over a range of altitudes.
Flight Mach number 0.81.
Figure 7. - The variation of corrected net thrust with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.
Figure 6. - The variation of corrected specific fuel consumption with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 6. - The variation of corrected specific fuel consumption with corrected inboard rotor speed over a range of altitudes.
Flight Mach number 0.81.
Figure 8. - The variation of corrected specific fuel consumption with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.

(c) Engine operation with both compressor bleed ports open.

- Dashed lines indicate 15,000 feet data from reference 1.
- At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.
- Cross marks indicate limiting turbine outlet temperature.
Figure 8. - The variation of corrected specific fuel consumption with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.

(d) Engine operation with the automatic control.

- Maximum throttle setting, both compressor bleed open.
- Idle throttle setting, small compressor bleed open.
- Idle throttle setting, both compressor bleeds closed.
(a) Engine operation with both compressor bleed ports closed.

Figure 9. - The variation of ideal jet thrust with exhaust nozzle pressure drop parameter over a range of altitudes. Flight Mach number 0.81.
Exhaust nozzle pressure drop parameter, $1.25 \frac{P_0 - P_o}{P_o}$, lbs/ft$^2$.

(b) Engine operation with the large compressor bleed port open.

Figure 9. - The variation of ideal jet thrust with exhaust nozzle pressure drop parameter over a range of altitudes. Flight Mach number 0.81.
### Ideal Jet Thrust, ft-lb

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<tr>
<th>Altitude, ft.</th>
<th>Exhaust nozzle pressure drop parameter, $1.25 P_3 - P_0$, lbs/ft²</th>
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<td>56,000</td>
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<td>60,000</td>
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-- Dashed lines indicate 15,000 feet data from reference 1.

**Figure 9.** The variation of ideal jet thrust with exhaust nozzle pressure drop parameter over a range of altitudes. Flight Mach number 0.81.
Figure 9. - The variation of ideal jet thrust with exhaust nozzle pressure drop parameter over a range of altitudes. Flight Mach number 0.81. Engine automatic control throttle settings of maximum and idle.
Figure 10. The variation of outboard compressor pressure ratio with corrected outboard rotor speed over a range of altitudes. Flight Mach number 0.81.
At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.

Cross marks indicate limiting turbine outlet temperature.

(b) Engine operation with the large compressor bleed port open:

Figure 10. — The variation of outboard compressor pressure ratio with corrected outboard rotor speed over a range of altitudes. Flight Mach number 0.62.
Figure 10. - The variation of outboard compressor pressure ratio with corrected outboard rotor speed over a range of altitudes.

- Flight Mach number 0.81.
- Cross marks indicate limiting turbine outlet temperature.
- At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.
Figure 10. - The variation of outboard compressor pressure ratio with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.
Figure 11. - The variation of outboard compressor efficiency with corrected outboard rotor speed over a range of altitudes. Flight Mach number 0.81.

Altitude, ft.
- 46,000
- 49,000
- 51,000
- 53,000
- 66,000
- 62,000
- 68,000

-- Solid line indicates 46,000 feet data only.
--- Dashed lines indicate 53,000 feet data from reference 1.

- At rotor speeds lower than those indicated by the solid points, compressor surge is encountered and no steady-state operation is possible.

Cross marks indicate limiting turbine outlet temperature.

Engine operation with both compressor bleed ports closed.
Figure 11. The variation of outboard compressor efficiency with corrected outboard rotor speed over a range of altitudes. Flight Mach number 0.81.

- At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.
- Cross marks indicate limiting turbine outlet temperature.

(b) Engine operation with the large compressor bleed port open.
At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.

Cross marks indicate limiting turbine outlet temperature.

(c) Engine operation with both compressor bleed ports open.

Figure 11. - The variation of outboard compressor efficiency with corrected outboard rotor speed over a range of altitudes. Flight Mach number 0.81.
(d) Engine operation with the automatic control.

Figure 11. - The variation of outboard compressor efficiency with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.
Figure 12. - The variation of corrected air flow with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.

(a) Engine operation with both compressor bleed ports closed.

- Solid line indicates 48,000 feet data only.
- Dashed lines indicate 15,000 feet data from reference 1.

At rotor speeds lower than those indicated by the solid points, compressor surge is encountered and no steady-state operation is possible.

Cross marks indicate limiting turbine outlet temperature.

At rotor speeds lower than those indicated by the solid points, compressor surge is encountered and no steady-state operation is possible.

Cross marks indicate limiting turbine outlet temperature.
Figure 12. - The variation of corrected air flow with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Altitude, ft.

- 46,000
- 49,000
- 51,000
- 53,000
- 56,000
- 58,000
- 62,000
- 65,000

--- Dashed lines indicate 15,000 feet data from reference 1.

- At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.

Cross marks indicate limiting turbine outlet temperature.

Figure 12: The variation of corrected air flow with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 12. - The variation of corrected air flow with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.

- Maximum throttle setting, both compressor bleeds closed.
- Idle throttle setting, small compressor bleed open.
- Idle throttle setting, both compressor bleeds open.

Altitude at a flight Mach number of 0.81.

Reynolds number index, $J_{/f} - \sqrt{\rho}$
Figure 13. - The variation of inboard compressor pressure ratio with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 13. The variation of inboard compressor pressure ratio with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
(c) Engine operation with both compressor bleed ports open.

Figure 13. - The variation of inboard compressor pressure ratio with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 13. - The variation of corrected inboard compressor pressure ratio with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.

- Maximum throttle setting, both compressor bleeds closed.
- Idle throttle setting, small compressor bleed open.
- Idle throttle setting, both compressor bleeds open.

Altitude at a flight Mach number of 0.81

Reynolds number index, $\delta_{1}/\delta_{1}'$, $\alpha_{1}$

(d) Engine operation with the automatic control.
Figure 14. - The variation of inboard compressor efficiency with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 14. - The variation of inboard compressor efficiency with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.

(b) Engine operation with the large compressor bleed port open.
Figure 14. - The variation of inboard compressor efficiency with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.

- - Dashed lines indicate 15,000 feet data from reference 1.

At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.

Cross marks indicate limiting turbine outlet temperature.

(c) Engine operation with both compressor bleed ports open.
Figure 14. - The variation of inboard compressor efficiency with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.
Figure 15. - The variation of overall compressor pressure ratio with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
(b) Engine operation with the large compressor bleed port open.

At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.

Cross marks indicate limiting turbine outlet temperature.

Figure 15. - The variation of over-all compressor pressure ratio with corrected inboard rotor speed over a range of altitudes.
Flight Mach number 0.81.
Figure 15. - The variation of over-all compressor pressure ratio with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 15. - The variation of over-all compressor pressure ratio with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.
Figure 16. - The variation of over-all compressor efficiency with corrected inboard rotor speed over a range of altitudes.

Flight Mach number 0.81.

(a) Engine operation with both compressor bleed ports closed.
Altitude, ft.

- 48,000
- 49,000
- 51,000
- 53,000
- 55,000
- 56,000
- 60,000
- 65,000

At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal. Cross marks indicate limiting turbine outlet temperature.

Corrected inboard rotor speed, $N_{10}/N_{1}$, rpm

Figure 16. - The variation of over-all compressor efficiency with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 16. - The variation of over-all compressor efficiency with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 16. - The variation of over-all compressor efficiency with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.

- Maximum throttle setting, both compressor bleeds closed.
- Idle throttle setting, small compressor bleed open.
- Idle throttle setting, both compressor bleeds open.
Figure 17. - The variation of combustor performance parameters with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.

(a) Engine operation with both compressor bleed ports closed.

- Dashed lines indicate 15,000 feet data from reference 1.
- At rotor speeds lower than those indicated by the solid points, compressor surge is encountered and no steady-state operation is possible. Cross marks indicate limiting turbine outlet temperature.
Figure 17. - The variation of combustor performance parameters with corrected inboard rotor speed over a range of altitudes.
Flight Mach number 0.81.
Altitude, --- Dashed lines indicate 15,000 feet data from reference 1.
- 46,000
- 49,000
- 51,000 
- 53,000 
- 56,000 
- 62,000 
- 65,000

- At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.

Cross marks indicate limiting turbine outlet temperature.

(c) Engine operation with both compressor bleed ports open.

Figure 17. - The variation of corrected combustor performance parameters with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.
Figure 17. - The variation of combustor performance parameters with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.

(d) Engine operation with the automatic control.

Reynolds number index, \( \delta/\rho \).
Figure 18. The variation of turbine performance parameters with corrected inboard rotor speed over a range of altitudes.

- Over-all turbine efficiency \( \eta_T \)
- Corrected turbine gas flow, \( \dot{m}_{GT} \)
- Turbine pressure ratio, \( \frac{P_4}{P_6} \)

Note: Dashed lines indicate data from 15,000 feet altitude. Points marked by the solid points, compensated on stage 3 for state operation as possible. Cross marks indicate limiting speed with COM pressure.
Figure 18. - The variation of turbine performance parameters with corrected inboard rotor speed over a range of altitudes.

Flight Mach number 0.81.

At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.

Cross marks indicate limiting turbine outlet temperature.

(b) Engine operation with the large compressor bleed port open.
Figure 18. - The variation of turbine performance parameters with corrected inboard rotor speed over a range of altitudes. Flight Mach number 0.81.

(c) Engine operation with both compressor bleed ports open.

- Dashed lines indicate 15,000 feet data from reference 1.
- At rotor speeds greater than those indicated by the solid points, compressor surge may be encountered and operation is marginal.
- Cross marks indicate limiting turbine outlet temperature.
Figure 18. - The variation of turbine performance parameters with altitude at a flight Mach number of 0.81. Engine automatic control throttle settings of maximum and idle.

(d) Engine operation with the automatic control.
PRELIMINARY PERFORMANCE DATA FOR THE J57-P-1 TURBOJET ENGINE AT ALTITUDES UP TO 65,000 FEET

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