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DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AERONAUTICAL SYSTEMS DIVISION (AFSC)

WRIGHT-PATTERSON AIR FORCE BASE OHIO 45433

REPLY TO ATTN OF: ASNPD 23 May 67

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Director of Engineering Standards

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WADC TECHNICAL NOTE 56-295

HAMILTON-STANDARD MODEL JFC12 CONTROL METERING CHARACTERISTICS

Mr. J. G. Barrett [redacted]
Power Plant Laboratory

9 July 1956

Project No. 3031-30142

Wright Air Development Center
Air Research and Development Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

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Technical Note
WADC 56-295
9 July 1956

Power Plant Laboratory
Directorate of Laboratories
Project No. 3031-30142

HAMILTON-STANDARD MODEL JFC12 CONTROL METERING CHARACTERISTICS

A. PURPOSE:

1. To obtain typical acceleration, deceleration and governing control characteristics of the Model JFC12 Fuel Control over a range of engine operating conditions and fuel density.

B. FACTUAL DATA:

2. The Model JFC12 control is a hydromechanical design produced by Hamilton-Standard for the model J57 engine. This control has as inputs the high pressure compressor turbine assembly rotating speed (N_2), burner pressure (P_B), and power lever angular position. It controls fuel flow through by-passing the excess output from a fixed displacement. Continuous hydromechanical computing establishes metering valve area. A constant metering head is held across the metering valve. Principle control provisions are described briefly as follows:

a. For engine acceleration a ratio of fuel flow rate to burner pressure (W_f/P_B) is held. Compressor inlet temperature trim (T_2) reduces the ratio at certain conditions in order to skirt compressor surge.

b. The deceleration provision is likewise a W_f/P_B ratio except where this would yield a fuel flow less than fixed minimum flow which is obtained on a minimum metering valve stop.

c. Speed governing is of the proportional type. Steady state N_2 is controlled by the intersection of the control generated curve and the engine fuel flow requirement. Inlet temperature bias (T_2) lowers the controlled N_2 as T_2 is reduced (to prevent N_1 from overspeed).

3. Hamilton-Standard Model JFC12, Part No. 95625, Serial No. 1572, was set-up in the Engine Accessories Laboratory for this test. The test was conducted on Meriam Test Stand Model No. D20399. The tests were conducted during the period of 3 - 10 May 1956. Two fuels were provided in order to have a range of specific gravity. These fuels were (a) MIL-F-7024A, specific gravity 0.765 at 80°F and (b) J15 with a specific gravity of 0.783 at 80°F.

4. The test results obtained are given in the attached curves. Significant notes on these curves are as follows:

a. Reference: Figure 1. A plot of the full throttle acceleration, governing and minimum flow with the two fuels at burner pressures of 5.0, 12.5 and 20.0 psia is shown. The curves represent typical very high altitude performance. The reduction of W_f/P_B to avoid compressor surge during acceleration is clearly shown.

b. Reference: Figure 2. A plot of idle throttle position metering for the conditions of overspeed, governing, and underspeed with the two fuels and range of burner pressures is given.

c. Reference: Figure 3. The plot of full throttle metering at inlet temperatures (T_2) of 72°F and -34°F is shown. The governor is seen to re-set by 200 control shaft RPM with this range of temperatures. The control exhibits approximately 20 RPM hysteresis as noted in the increasing vs. decreasing run. The curve also shows the surge notch which progressively comes into effect as T_2 is reduced.

d. Reference: Figure 4. This curve illustrates the increase in fuel flow as burner pressure is increased. The full curve is given for P_B of 150 psia and T_2 of 72°F, a condition approximating ground level performance.

The above curves may be used by interpolation to define specific control performance within the range of test conditions.

5. The fuel density effect on metering was determined to approximate the square root of the specific gravity ratio. Metered flow increased an average of 1.2% for a specific gravity increase from 0.765 to 0.783.

C. CONCLUSIONS:

6. Typical accelerating, decelerating and governing curves of the JFC12 control were determined covering a range of altitude conditions (P_B), power lever angle, inlet temperature and fuel density.

D. RECOMMENDATIONS:

7. None. Data merely submitted.

COORDINATION:

R. E. Hoffman

R. E. HOFFMAN, Chief
ENGINE ACCESSORIES BRANCH

PREPARED BY:

James G. Barrett

JAMES G. BARRETT, WCLPG-2

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

for E. C. Phillips
NORMAN C. APPOLD
Colonel, USAF
Chief, Power Plant Laboratory

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FIGURE 1

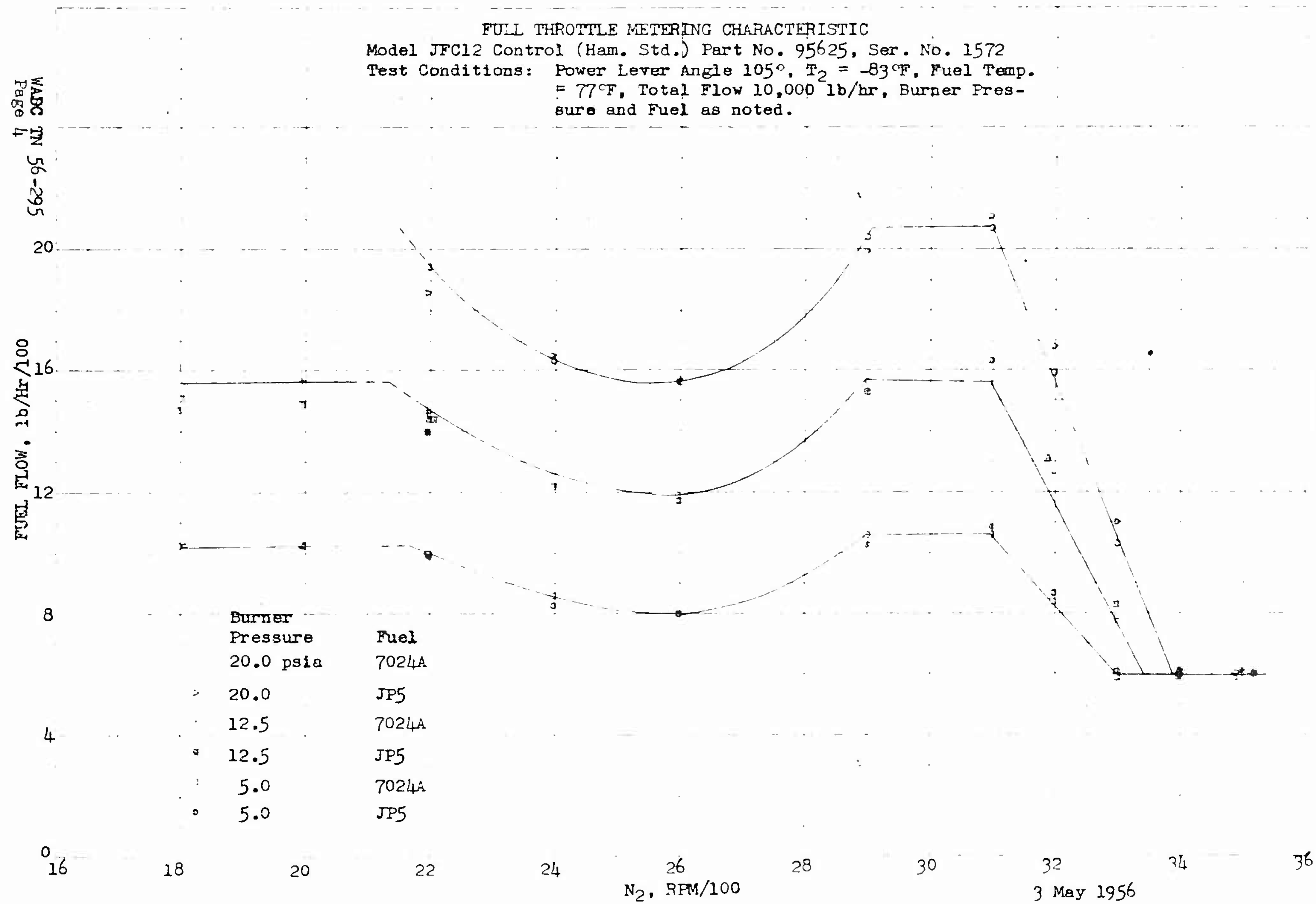

FULL THROTTLE METERING CHARACTERISTIC
Model JFC12 Control (Ham. Std.) Part No. 95625, Ser. No. 1572
Test Conditions: Power Lever Angle 105°, T2 = -83°F, Fuel Temp. = 77°F, Total Flow 10,000 lb/hr, Burner Pressure and Fuel as noted.
FUEL FLOW, lb/Hr/100
0
4
8
12
16
20
16
18
20
22
24
26
28
30
32
34
36
N2, RPM/100
Burner Pressure
Fuel
20.0 psia
7024A
20.0
JP5
12.5
7024A
12.5
JP5
5.0
7024A
5.0
JP5
3 May 1956

FIGURE 2

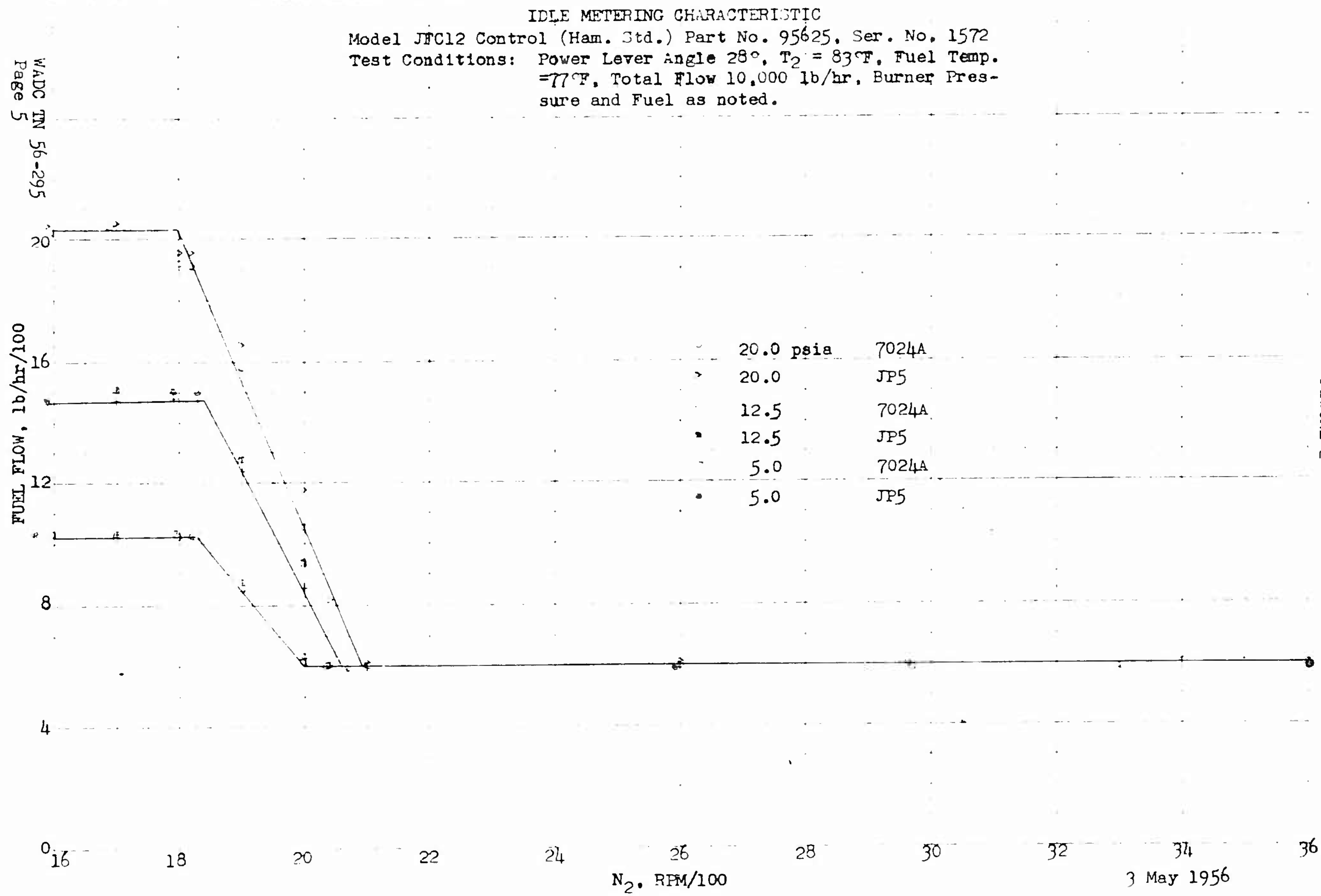
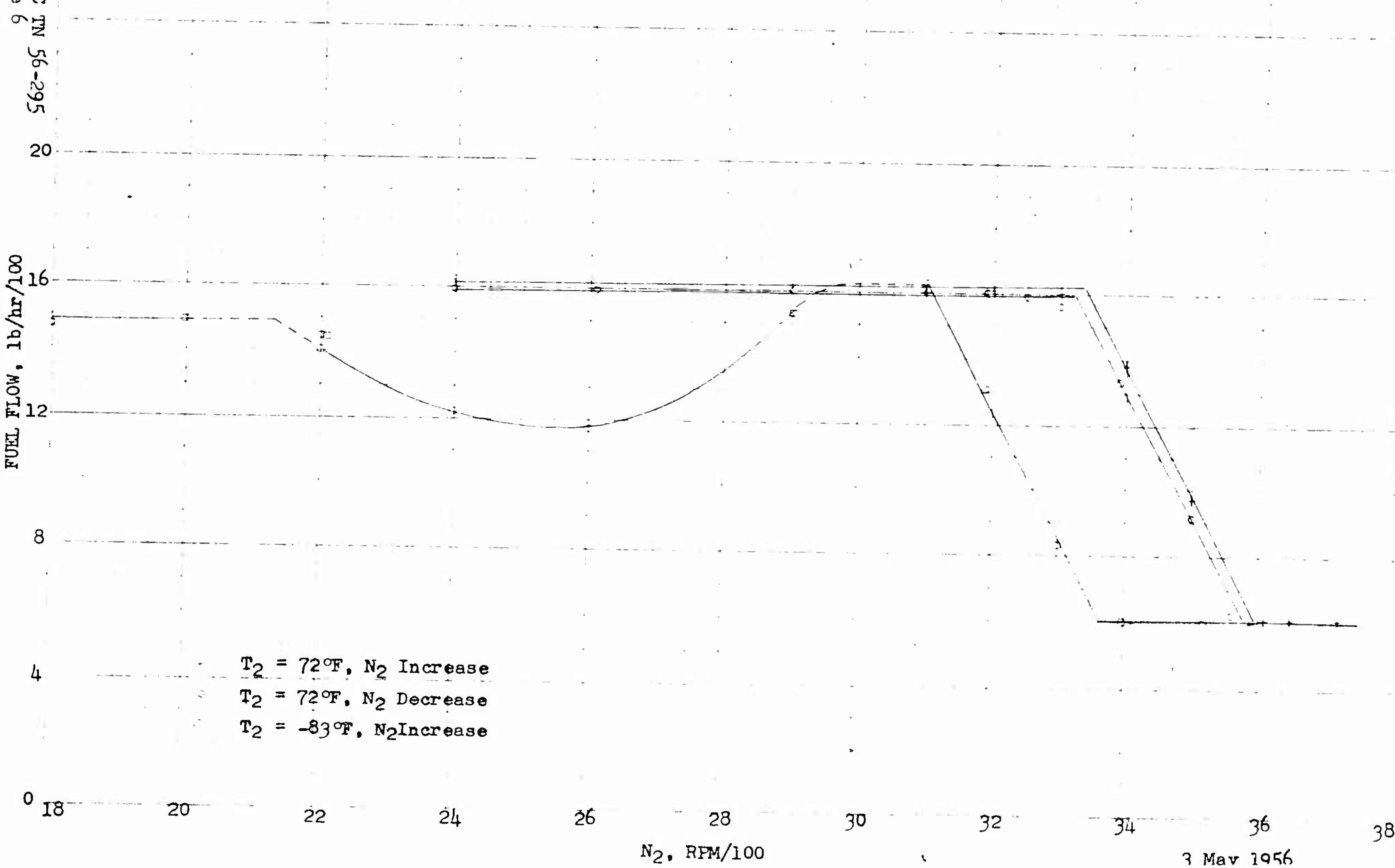

IDLE METERING CHARACTERISTIC
Model JFC12 Control (Ham. Std.) Part No. 95625, Ser. No. 1572
Test Conditions: Power Lever Angle 28°, T_2 = 83°F, Fuel Temp. =77°F, Total Flow 10,000 lb/hr, Burner Pressure and Fuel as noted.
20.0 psia 7024A
20.0 JP5
12.5 7024A
12.5 JP5
5.0 7024A
5.0 JP5
FUEL FLOW, lb/hr/100
0
4
8
12
16
20
16
18
20
22
24
26
28
30
32
34
36
N_2, RPM/100
3 May 1956

FIGURE 3

INLET AIR TEMPERATURE EFFECT AT FULL THROTTLE

~~Model JFG12 Control (Ham. Std.) Part No.~~ 95625, ~~Ser. No.~~ 1572

Test Conditions: Power Lever Angle 105°, Fuel Temp. 27°F, Total Flow 10,000 lb/hr., Burner Pressure 12.5 psia., JP5 Fuel Inlet Temp (T_2) as noted.



3 May 1956

FIGURE 4

BURNER PRESSURE AT FULL THROTTLE

Model JFC12 Control (Ham. Std.) Part No. 95625, Ser. No. 1572

Test Conditions: Power Lever Angle 105°, JP5 Fuel, Fuel Temp. 77°F, T_2 = 72°F, Total Flow selected, Burner Pressure as noted.