

Restriction/Classification
Cancelled

Source of Acquisition
CASI Acquired

CONFIDENTIAL

Copy 20
RM SE50L29



RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Department of the Navy

PRELIMINARY TRANSIENT PERFORMANCE DATA FOR AFTERBURNER
OPERATION OF WESTINGHOUSE ELECTRONIC POWER REGULATOR
ON XJ34-WE-32 TURBOJET ENGINE IN ALTITUDE WIND TUNNEL

By George Vasu, Glennon V. Schwent, and James R. Ketchum

Lewis Flight Propulsion Laboratory
Cleveland, Ohio

CLASSIFICATION CHANGE

To Unclassified
By authority of RA-4562
Changed by M. Ruda Date 5-22-74

Restriction/
Classification
Cancelled

This document
contains information
relating to the
National Defense of the United States within the
meaning of the
transmission or the revelation of its contents in any
manner to an unauthorized person in the military and naval services of the United
States, appropriate Federal Government who have a legitimate interest
therein, and to whom discretion who of necessity must be informed thereof.

DOCUMENT
ing the National Defense of the United States within the
transmission or the revelation of its contents in any
persons in the military and naval services of the United
the Federal Government who have a legitimate interest
and discretion who of necessity must be informed thereof.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WASHINGTON
FEBRUARY 14 1951

FILE COPY

To be returned to
the files of the National
Advisory Committee
for Aeronautics
Washington, D. C.

CONFIDENTIAL

NACA RM SE50L29

NACA RM SE50L29

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Department of the Navy

PRELIMINARY TRANSIENT PERFORMANCE DATA FOR AFTERBURNER OPERATION OF
WESTINGHOUSE ELECTRONIC POWER REGULATOR ON XJ34-WE-32

TURBOJET ENGINE IN ALTITUDE WIND TUNNEL

By George Vasu, Glennon V. Schwent, and James R. Ketchum

INTRODUCTION

At the request of the Bureau of Aeronautics, Department of the Navy, an investigation of the Westinghouse XJ34-WE-32 turbojet engine is being conducted in the NACA Lewis altitude wind tunnel to determine the steady-state and transient operating characteristics of the controlled and uncontrolled engine at various altitudes and ram pressure ratios. As part of this program, transient performance data that illustrate the operation of the engine is obtained in the form of oscillographic traces. Representative data of the controlled engine for operation in the nonafterburning range is presented in reference 1. Similar data for engine operation in the afterburning range, covering a range of throttle settings from the minimum value giving rated speed (throttle position, 72°) to full afterburning (throttle position, 110°), is presented herein. These data thus serve to indicate the transient characteristics of the engine when the throttle is advanced into, withdrawn from, and moved within the afterburning range in a stepwise manner, as well as the steady-state stability of the engine during afterburning.

The oscillographic traces presented herein show the responses of the following parameters to step changes in throttle position: thrust, ram pressure ratio, exhaust-nozzle area, engine speed, turbine-discharge temperature, primary fuel valve position, compressor-discharge pressure, afterburner fuel flow, primary engine fuel flow, turbine-discharge pressure, throttle position, afterburner igniter pressure, and pressures in the three afterburner fuel manifolds. These data are presented for

a range of altitudes from 10,000 to 45,000 feet and at several ram pressure ratios. In addition, data are presented to show operation with different schedules of afterburner fuel flow against compressor-discharge pressure.

APPARATUS

Engine. - XJ34-WE-32 turbojet engine with variable-area exhaust nozzle and afterburner

Minimum primary fuel flow set to 420 pounds per hour at a windmilling speed of 1500 rpm and an altitude of 2000 feet

Control. - Westinghouse electronic power regulator (part no. 61-F-758-4; serial no. S-CZA-78, modified to correspond to part no. 61-F-758-6 insofar as temperature schedule is concerned)

The original thermocouple harness of nine paralleled short thermocouples at the turbine discharge was removed and replaced by another group of nine paralleled elements which were emersed 6 inches. The thermocouples were also of equal resistance to insure more nearly average temperature indication.

Test facilities. - Lewis altitude wind tunnel with 20-foot diameter test section

Air supplied through a ram pipe connected directly to the engine

Instrumentation. - Engine parameters were recorded during transients on three multichannel direct-inking magnetic-pen-motor oscillographs. The pen motor in combination with its amplifier has an essentially flat frequency response to approximately 100 cycles per second. The oscillograph chart speed was 2.5 units per second. Timing marks are shown on the lower edge of the oscillograph reproductions. These marks serve as a reference for determining a starting point for the time bases of the three recorders. The following table lists the engine parameters that were recorded, the instrumentation used to measure the values of the parameters in the steady state, the sensing devices used to measure the variations in the parameters during transients, and the frequency-response range of the transient instrumentation.

Measured quantity	Steady-state instrumentation	Transient instrumentation	
		Sensor	Range over which frequency response is essentially flat (cycles/sec)
Thrust		Strain gage mounted on strain link attached to forward engine suspension	0-100
Ram pressure ratio	Airspeed indicator	Aneroid-type pressure sensor with strain gage element	0-10 at sea-level pressure
Exhaust-nozzle area	Microammeter connected to exhaust-nozzle area feedback potentiometer	Exhaust nozzle area feedback potentiometer connected to give position indication	0-100
Engine speed	Chronometric tachometer	Direct current tachometer generator	0-5
Turbine discharge temperature	Nine thermocouples in parallel connected to Brown recorder (Westinghouse control thermocouple harness)	Unshielded loop thermocouples (five in series)	0-1 at sea-level mass flow
Primary fuel valve position	Microammeter connected to fuel valve feedback potentiometer	Fuel valve feedback potentiometer connected to give position indication	0-100
Compressor discharge pressure	Mercury filled manometer	Aneroid-type pressure sensor with strain gage element	0-10 at sea-level pressure
Afterburner fuel flow	Rotameter	Aneroid-type pressure sensor, with strain gage element, connected to measure pressure drop across a fixed orifice in the fuel line	Undetermined
Primary fuel flow	Rotameter	Aneroid-type pressure sensor, with strain gage element, connected to measure pressure drop across a variable orifice in the fuel line	Undetermined
Turbine discharge pressure	Alkazine filled manometer	Aneroid-type pressure sensor with strain gage element	0-10 at sea-level pressure
Throttle position	Selsyn indicator	Wire-wound potentiometer connected to give position indication	0-100
Afterburner igniter pressure		Aneroid-type pressure sensor with strain gage element	Undetermined
Afterburner manifold pressure (inner ring)	Bourdon-type gage	Aneroid-type pressure sensor with strain gage element	Undetermined
Afterburner manifold pressure (middle ring)	Bourdon-type gage	Aneroid-type pressure sensor with strain gage element	Undetermined
Afterburner manifold pressure (outer ring)	Bourdon-type gage	Aneroid-type pressure sensor with strain gage element	Undetermined



PROCEDURE

The throttle was manually advanced or cut back in a stepwise manner within the range of throttle positions from 72° to full afterburning to determine the transient operation of the engine and control. Engine parameters were measured continuously on oscillograph recorders. Before and after each transient, photographs of panel meters and manometers were taken to calibrate the transient traces.

In the original afterburner control system, fuel flow is scheduled as a function of compressor-discharge pressure. This scheduling was selected so that fuel flow would be proportional to air flow through the engine for any condition of flight speed, altitude, or ambient temperature.

Inasmuch as one of the objectives of this study was to determine effects of variations in the schedule, it became necessary to modify the original control so as to permit such changes to be made conveniently. An analysis of the original system shows that compressor-discharge pressure is referenced to a constant pressure, which is essentially the fuel boost pump outlet pressure, and that this function then controls fuel flow. It is evident that changes in the reference pressure will cause a change in fuel flow at any one value of compressor-discharge pressure. In order to change the schedule, the fuel flow return line from the afterburner control that had been connected to the boost pump outlet pressure as a reference point was moved to the boost pump inlet pressure as a new reference point. A schematic diagram of the fixed system, as modified, is presented in figure 1.

Pump inlet pressure was then set to each of several values and in each case held constant for a series of transient runs. The engine was operated in the afterburner region in accordance with the new schedules thus established. Transient data were taken with several boost pump inlet pressures.

Throttle position steps of various sizes were made within the range of 72° to full afterburning at the following flight conditions:

Simulated altitude (ft)	Nominal inlet temperature (°F)	Nominal ram pressure ratio
10,000	60	1.2
25,000	0	1.2
35,000	-11	1.2
40,000	-10	1.05
40,000	-11	1.2
45,000	-14	1.4

PRESENTATION OF DATA

Preliminary data are presented in the form of reproductions of oscillographic traces which have been reduced to 71 percent of their original size (except fig. 41 which is reduced to 54 percent of its original size). These data are representative of the operation of the controlled engine with afterburner in the range of throttle positions from 72° to full afterburning.

For all runs, the following parameters are shown:

Thrust

Ram pressure ratio

Exhaust-nozzle area

Engine speed

Turbine-discharge temperature

Primary fuel valve position

Compressor-discharge pressure

Afterburner fuel flow

Primary fuel flow

Turbine-discharge pressure

Throttle position

Afterburner igniter pressure

Afterburner manifold pressure (inner ring)

Afterburner manifold pressure (middle ring)

Afterburner manifold pressure (outer ring)

The average steady-state value for the preceding parameters are indicated on the individual oscillographic traces, except for the jet thrust and afterburner igniter records. These traces are shown only to indicate the variation during a transient. Because of the techniques employed in measuring jet thrust, variations in ram pressure influence the thrust trace. This effect of ram variation on thrust can be observed by noting the thrust trace when ram varies.

As an aid in the understanding and interpretation of the transient runs, a nominal power control lever schedule for static sea-level operation is presented in figure 2. This figure shows the temperature, speed, and approximate thrust scheduled for each throttle position. Linearity of thrust is not guaranteed; instead, speed and temperature are controlled and thrust will be whatever is obtained at a given set speed and set temperature. A calibration of exhaust-nozzle area to its panel meter reading is presented in figure 3. Afterburner fuel flow schedules for several boost pump inlet pressures are shown in figure 4. 2097

The oscillographic traces of the transient data are presented in figures 5 to 48 and are indexed in table I according to throttle position, altitude, ram pressure ratio, and boost pump inlet pressure. The figures chosen are representative of the normal operation of the controlled engine with afterburning within the range of throttle positions from 72° to full afterburning with the exception of figures 23 to 27 inclusive where boost pump inlet pressure was 30 pounds per square inch. It was found that the afterburner manifold inner ring had been partially coked when the data for figures 23 to 27 had been taken. This coking is indicated by the high pressure in the inner ring relative to that in the other rings. As a result of this coking, the afterburner fuel flow is less than normal and therefore less than that scheduled. The fuel flow and responses obtained in this particular case with partial coking are similar to those obtained with a boost pump inlet pressure of 26 pounds per square inch without coking. One point on figure 4 for a boost pump inlet pressure of 18 pounds per square inch is somewhat low, which is also due to partial coking of the fuel manifold. The only effect of partial coking appears to be a reduction in afterburner fuel flow. More severe coking than that discussed above, however, results in oscillatory engine response.

Lewis Flight Propulsion Laboratory,
National Advisory Committee for Aeronautics,
Cleveland, Ohio, January 16, 1951.

REFERENCE

1. Ketchum, James R., Blivas, Darnold, and Pack, George J.: Preliminary Performance Data on Westinghouse Electronic Power Regulator Operating on J34-WE-32 Turbojet Engine in Altitude Wind Tunnel. NACA RM SE50J11, Bur. Aero., 1950.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Department of the Navy

PRELIMINARY TRANSIENT PERFORMANCE DATA FOR AFTERBURNER OPERATION OF

WESTINGHOUSE ELECTRONIC POWER REGULATOR ON XJ34-WE-32

TURBOJET ENGINE IN ALTITUDE WIND TUNNEL

George Vasu

George Vasu,
Aeronautical Research Scientist.

Glenn V. Schwent/gvf

Glenn V. Schwent,
Aeronautical Research Scientist.

James R. Ketchum

James R. Ketchum,
Aeronautical Research Scientist.

Approved:

John C. Sanders

John C. Sanders,
Aeronautical Research Scientist.

Eugene W. Wasielewski

Eugene W. Wasielewski,
Aeronautical Research Scientist.

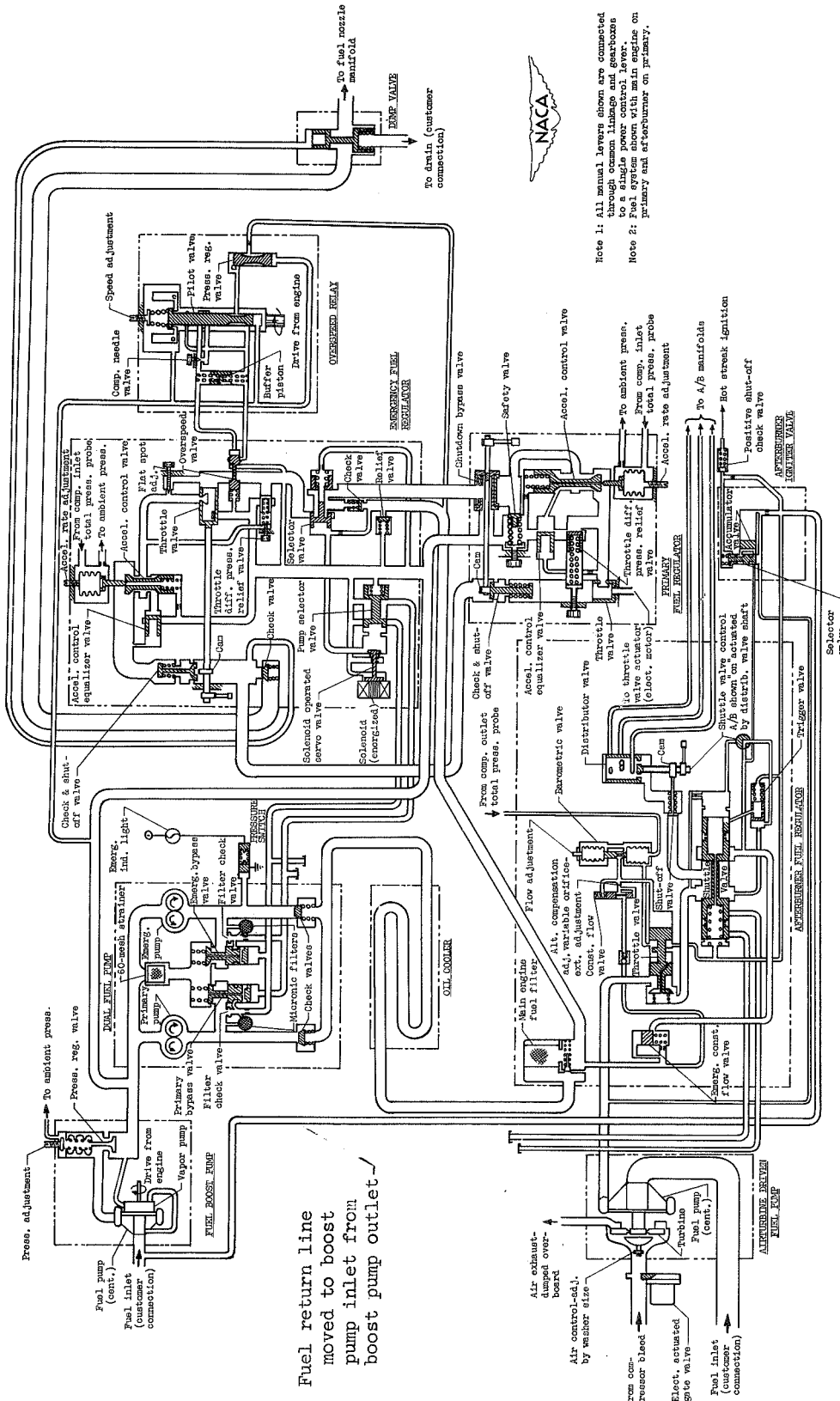
cag

TABLE I - INDEX TO TRANSIENT RUNS

Figure	Throttle position (deg)		Altitude (ft)	Nominal ram pressure ratio	Boost pump inlet pressure (lb/sq in.)
	Initial	Final			
5	82	110	10,000	1.2	18
6	110	82		1.2	18
7	82	104		1.2	18
8	106	110		1.2	18
9	110	90		1.2	18
10	72	111	25,000	1.2	18
11	111	72		1.2	18
12	83	111		1.2	18
13	111	83		1.2	18
14	96-111	96		1.2	18
15	72	110		1.2	26
16	110	72		1.2	26
17	83	110		1.2	26
18	110	83		1.2	26
19	110-97	110		1.2	26
20	110-101	110		1.2	26
21	105	110		1.2	26
22	110	93 and cut off		1.2	26
23	72	108		1.2	a ₃₀
24	108	72	1.2	a ₃₀	
25	82	108	1.2	a ₃₀	
26	108	82	1.2	a ₃₀	
27	108-90	82	1.2	a ₃₀	
28	72	109	35,000	1.2	18
29	109	72		1.2	18
30	82	108		1.2	18
31	109	85		1.2	18
32	106	109		1.2	18
33	109-101	109		1.2	18
34	109-97	109-93-75		1.2	18
35	82	108	40,000	1.05	26
36	108	84		1.05	26
37	73	108		1.2	18
38	108	73		1.2	18
39	82	108		1.2	18
40	108	82		1.2	18
41	108-94	108-93		1.2	18
42	72	110	45,000	1.4	18
43	110	72		1.4	18
44	83	110		1.4	18
45	110	83		1.4	18
46	110-104	110		1.4	18
47	110-100	110		1.4	18
48	109-94	109		1.4	18

^aAfterburner inner ring coked (see text).





Note 1: All manual levers shown are connected through common linkage and gearboxes.
Note 2: Fuel system shown with main engine on primary and afterburner on primary.

Fuel return line moved to boost pump inlet from boost pump outlet

Figure 1. - Schematic diagram of XJ34-WE-32 fuel system (taken from Westinghouse manual).

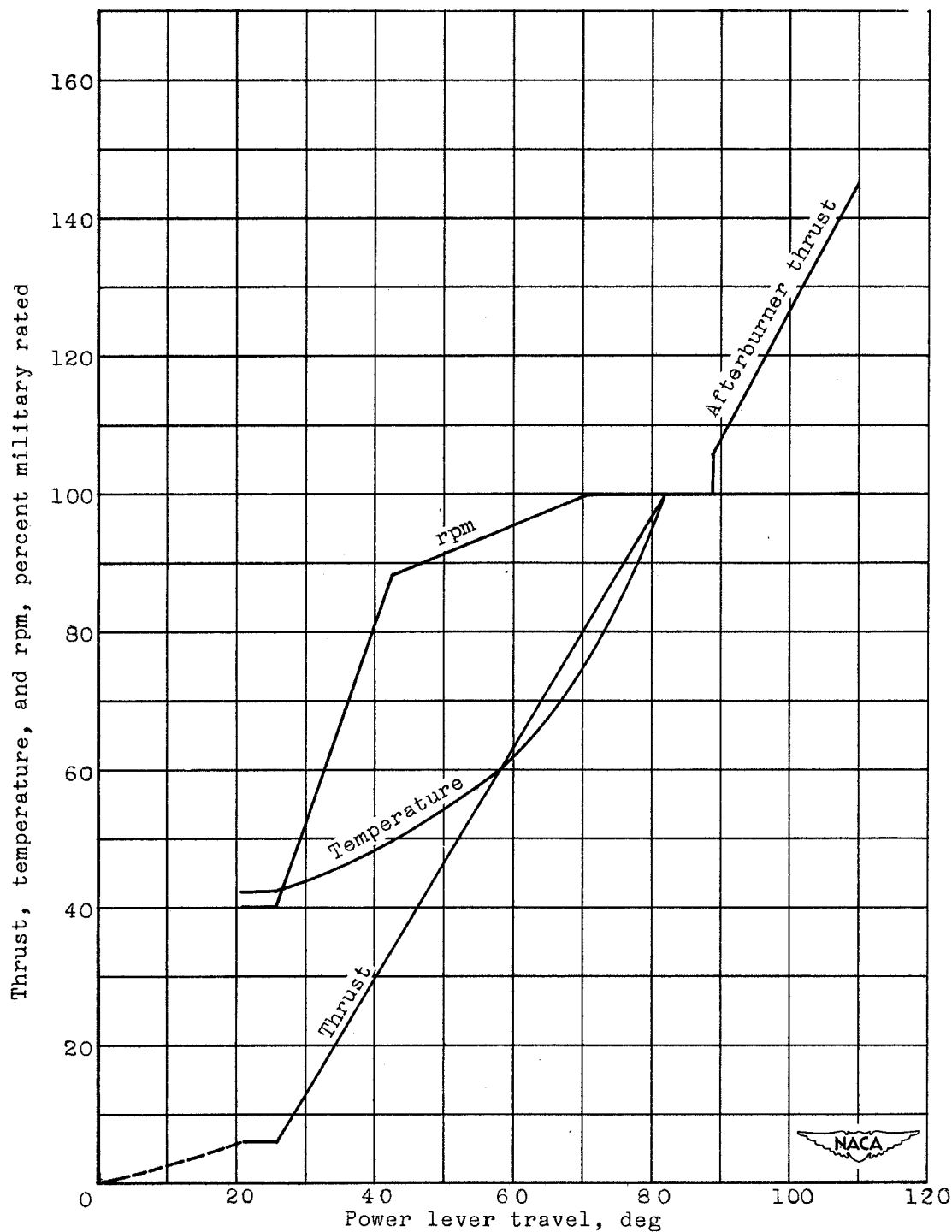


Figure 2. - Nominal power control lever schedule for static sea-level operation of typical engine.

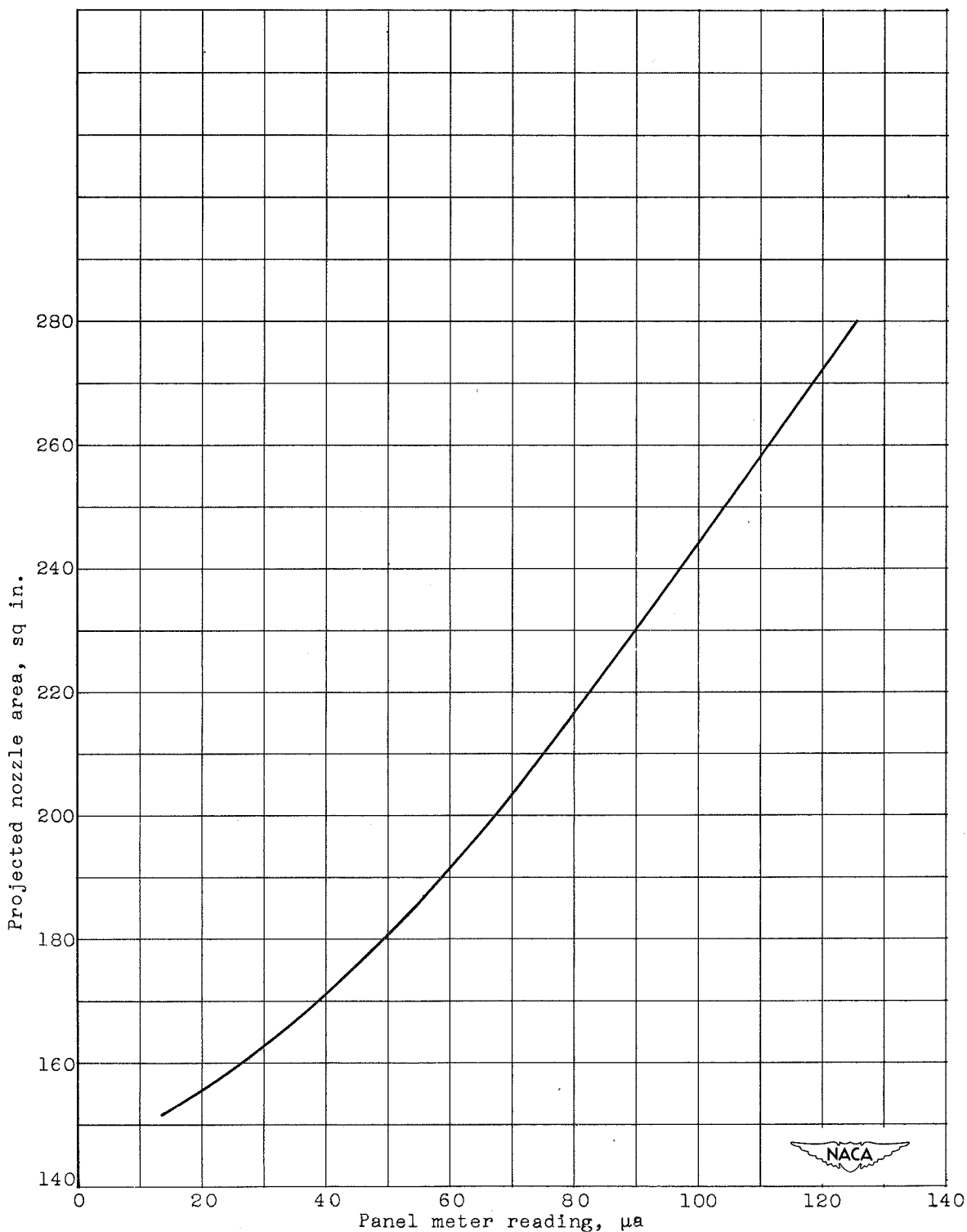


Figure 3. - Calibration of exhaust-nozzle area.

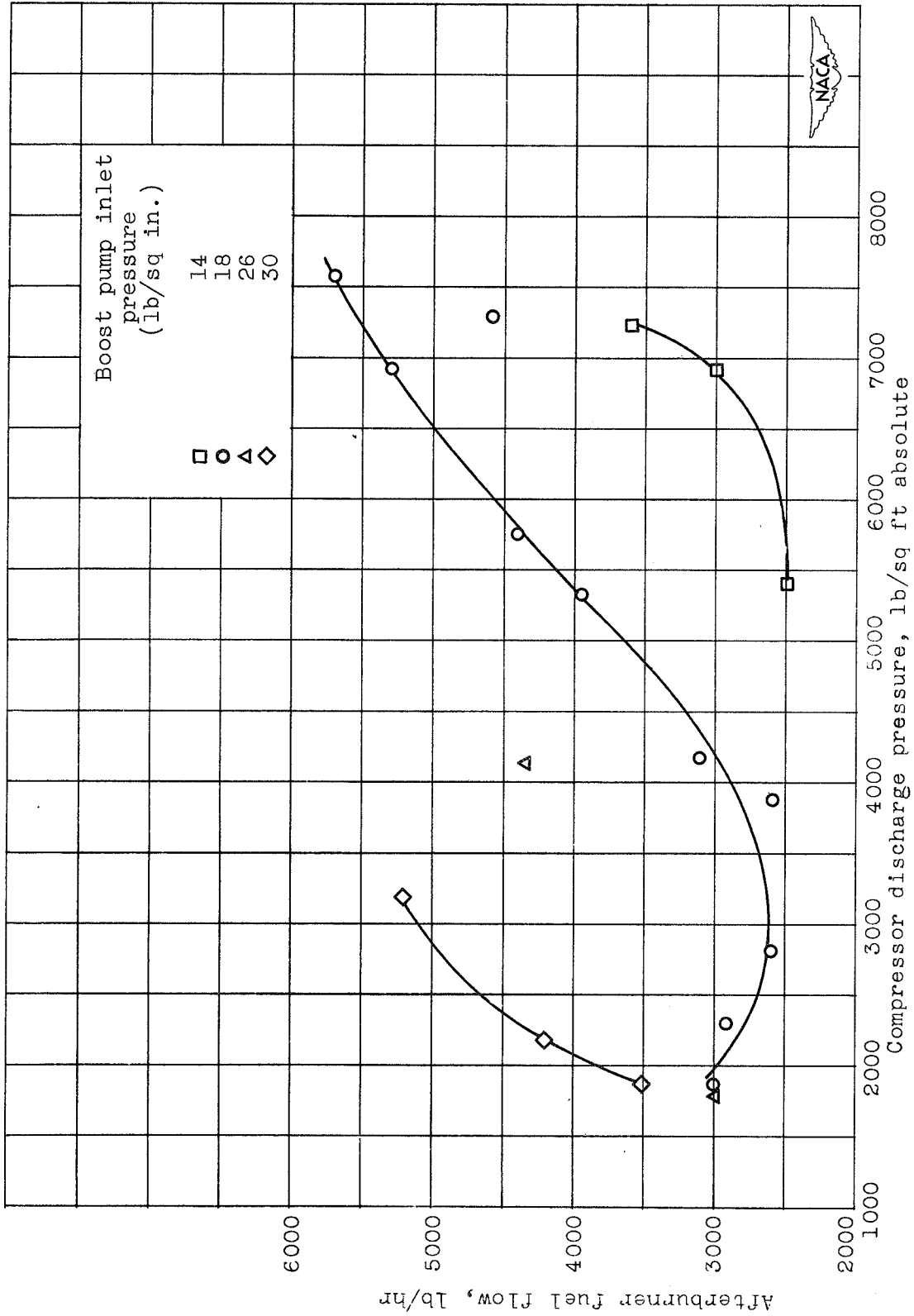


Figure 4. - Afterburner fuel-flow schedules.

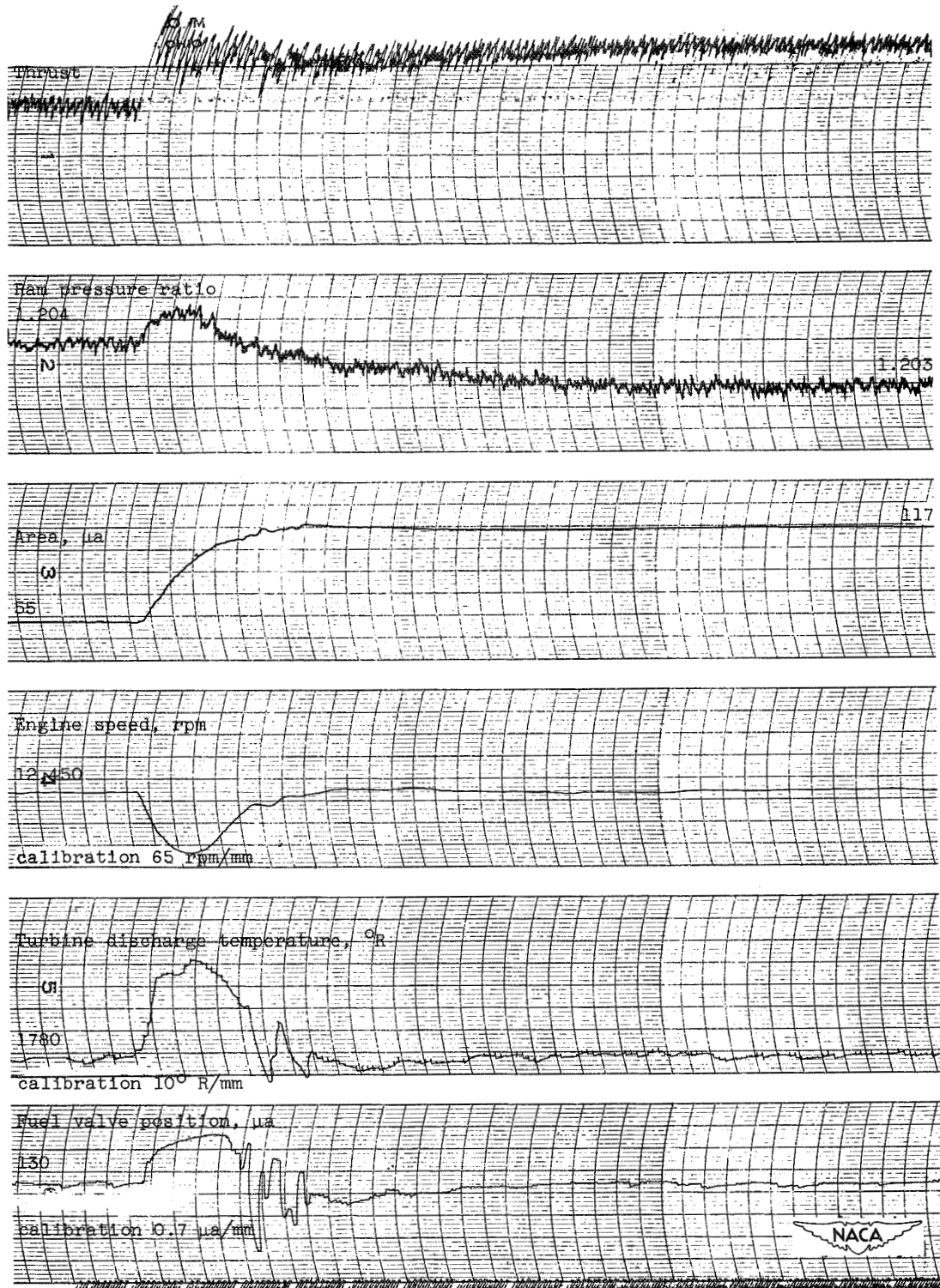


Figure 5. - Transient operation of automatically controlled engine with after-burner. Throttle position, 82° to 110° ; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

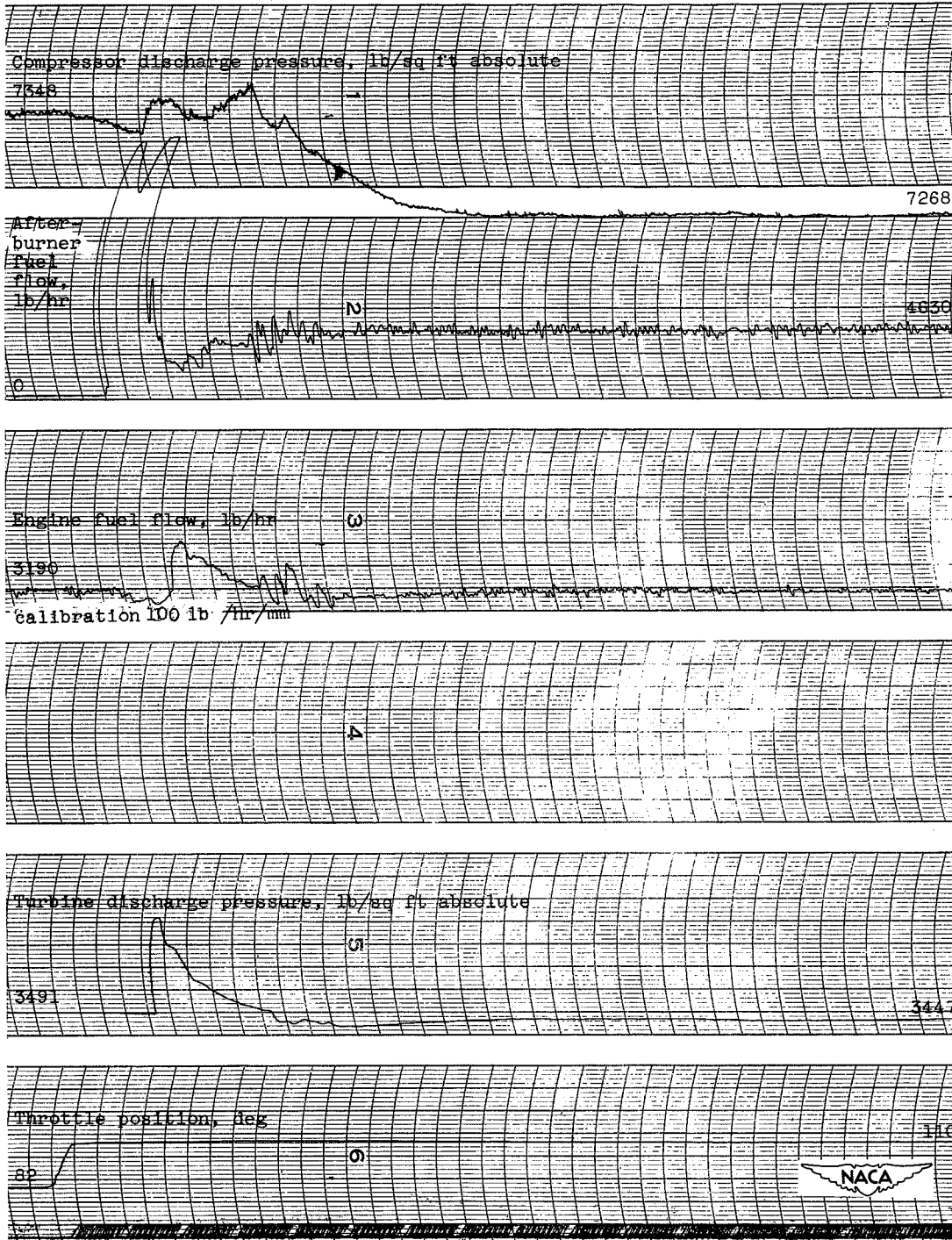


Figure 5. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 110°; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

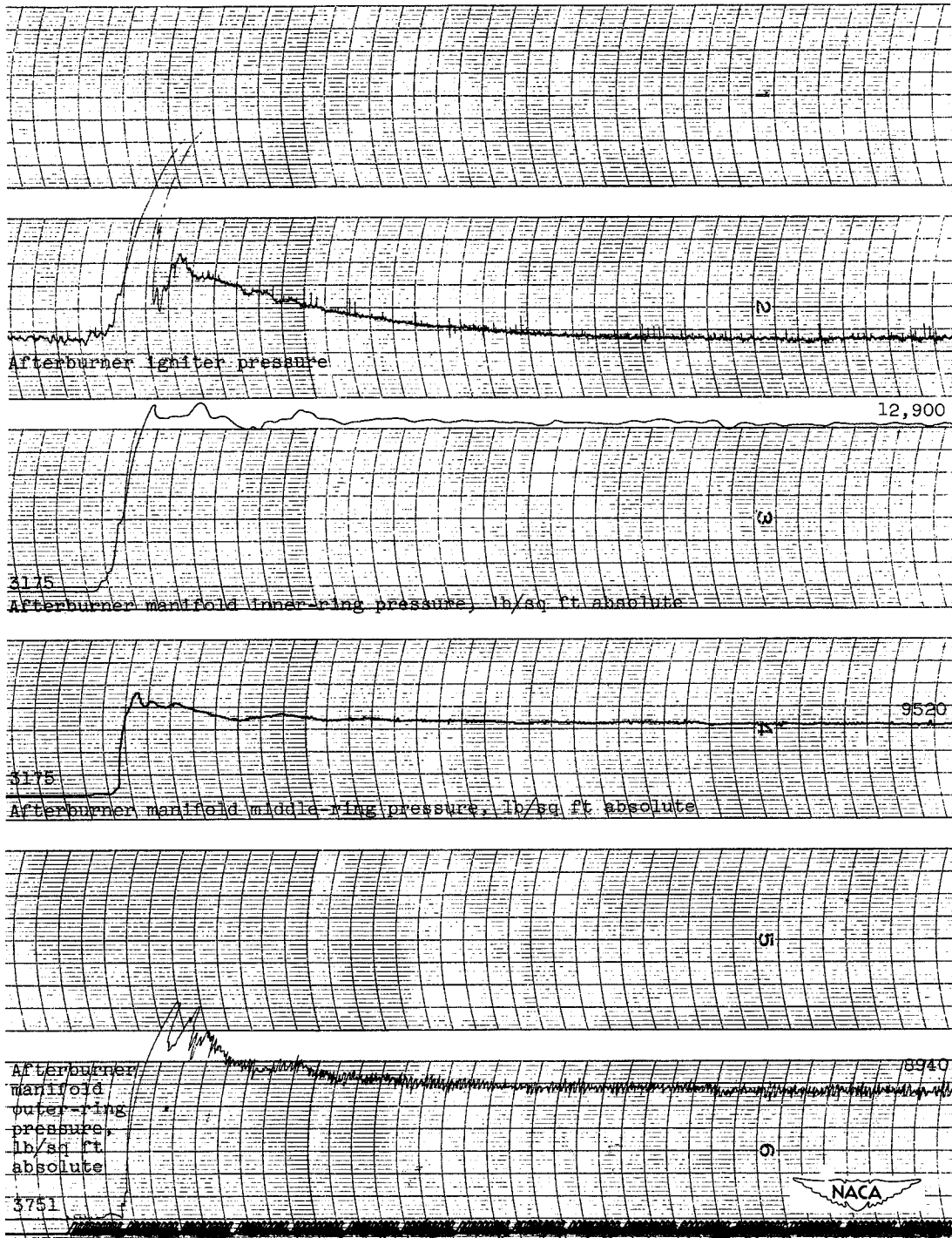


Figure 5. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 110°; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

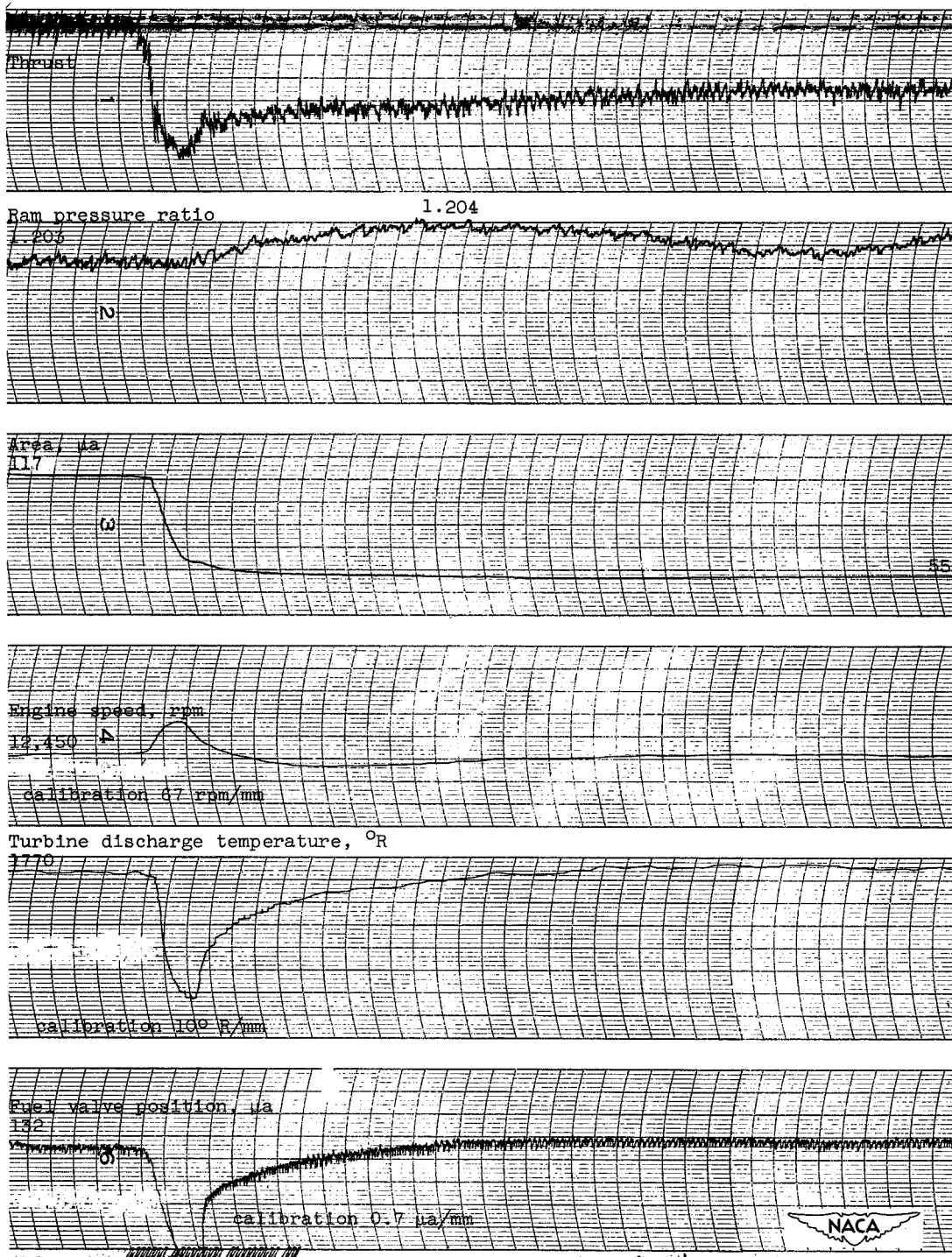


Figure 6. - Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 82° ; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

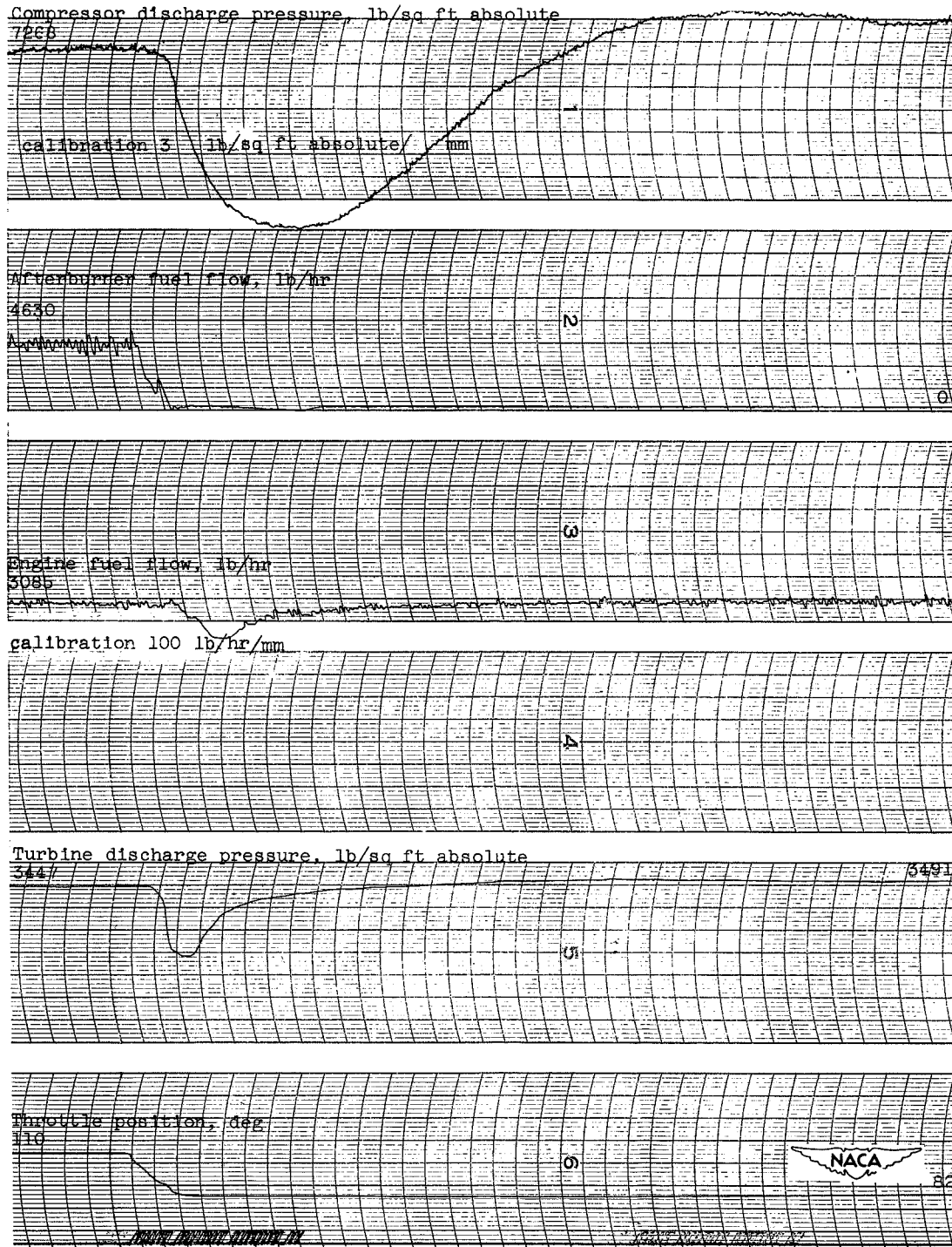


Figure 6. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 82°; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

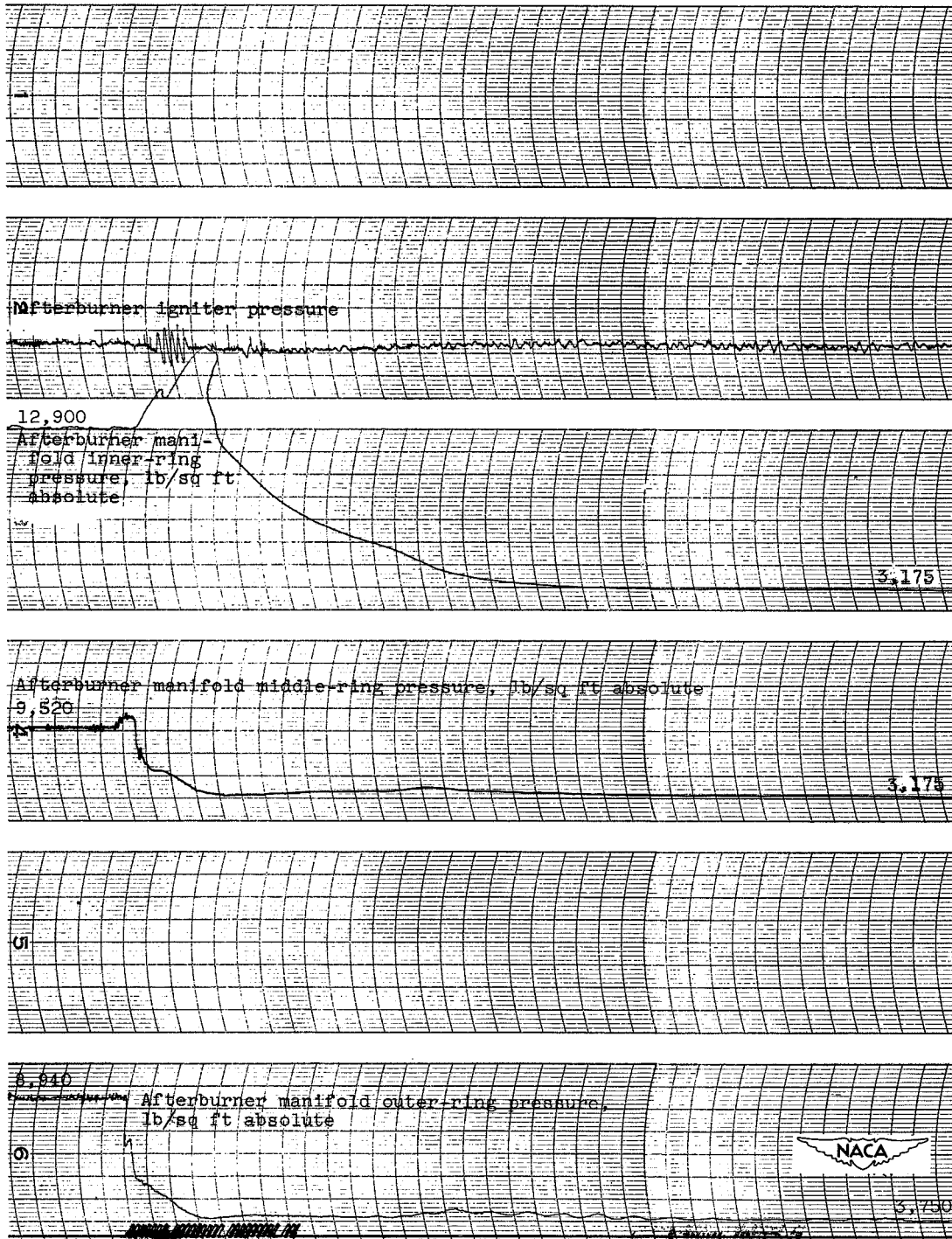


Figure 6. - Concluded. - Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 82°; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

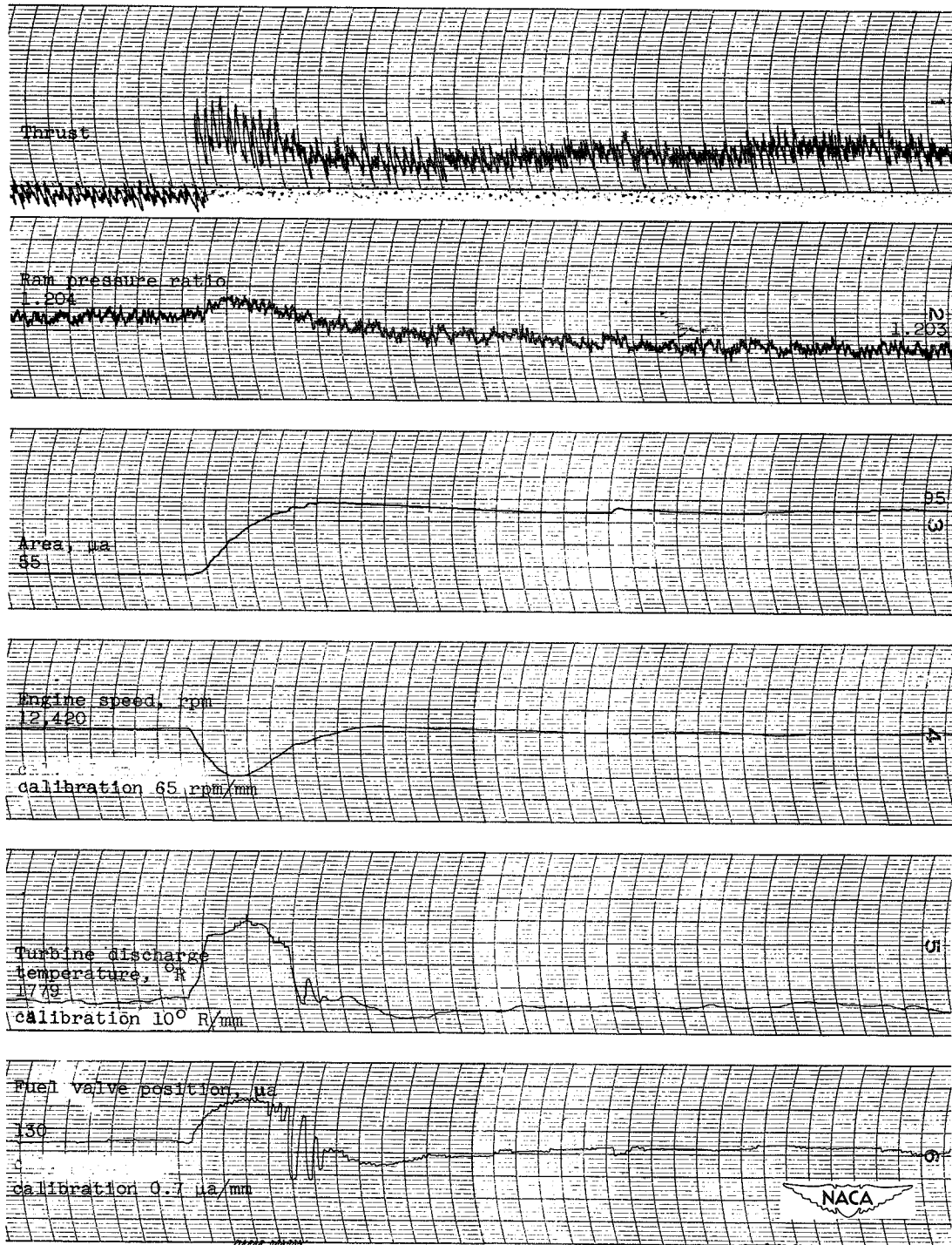


Figure 7. - Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 104° ; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

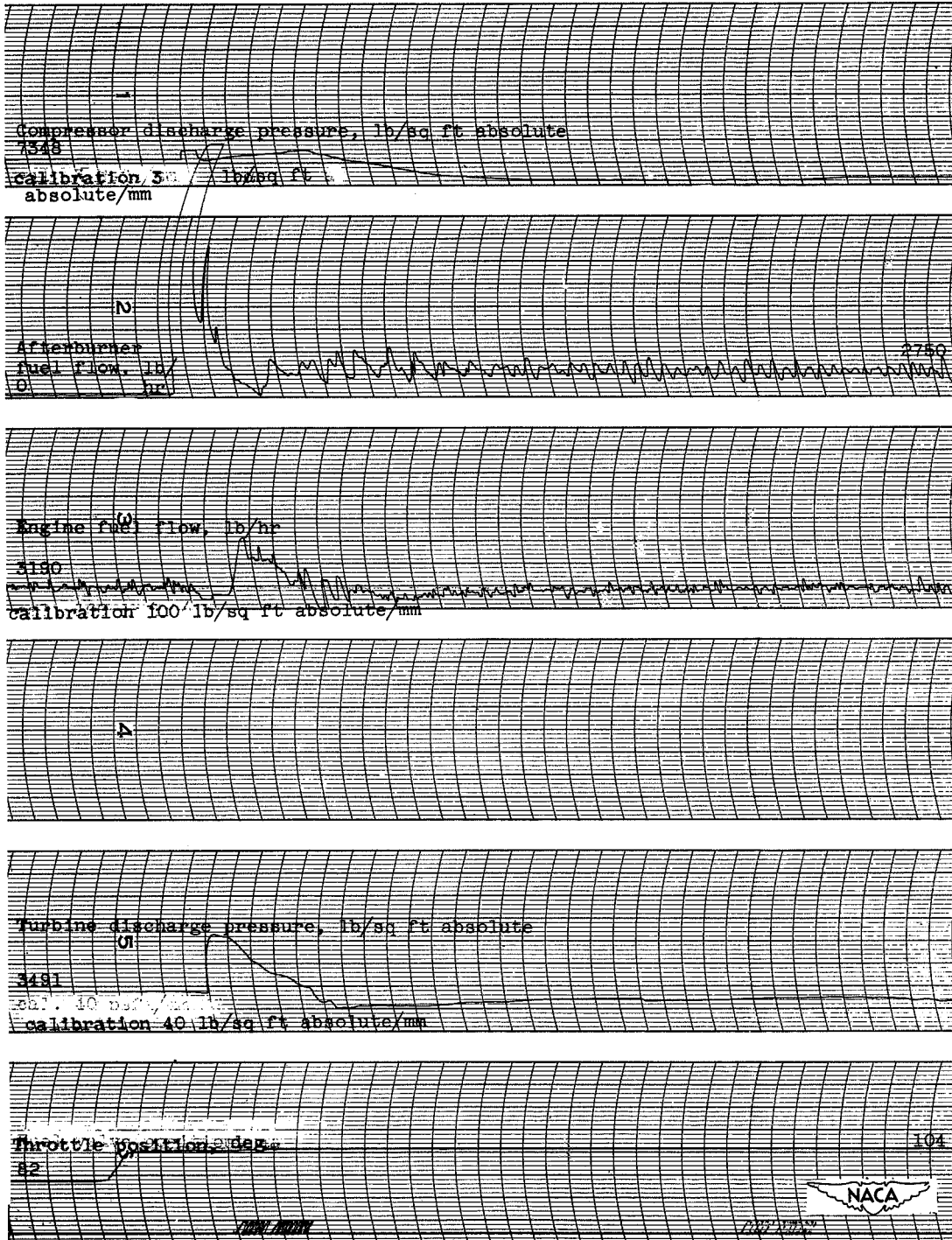


Figure 7. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 104°; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

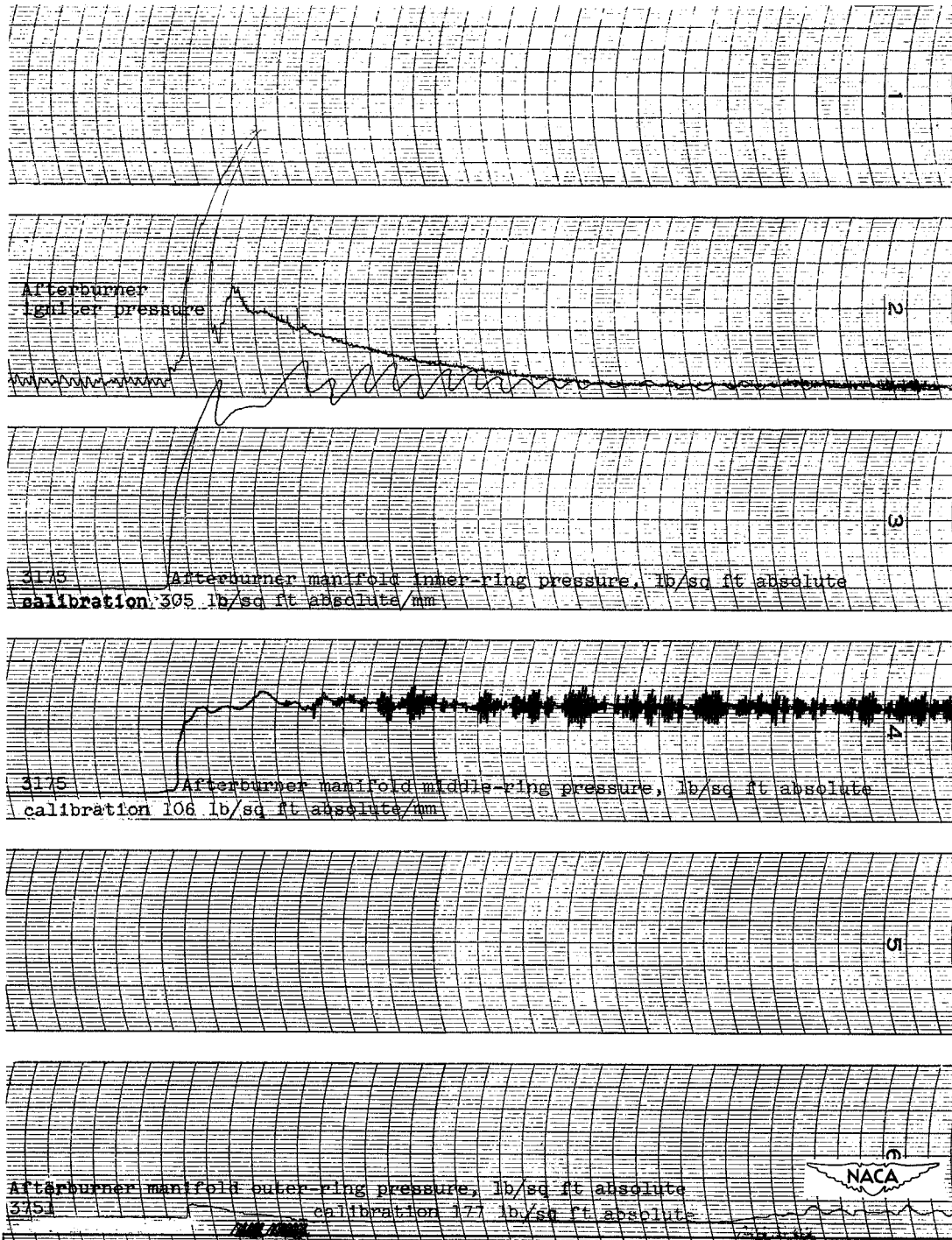


Figure 7. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 104°; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

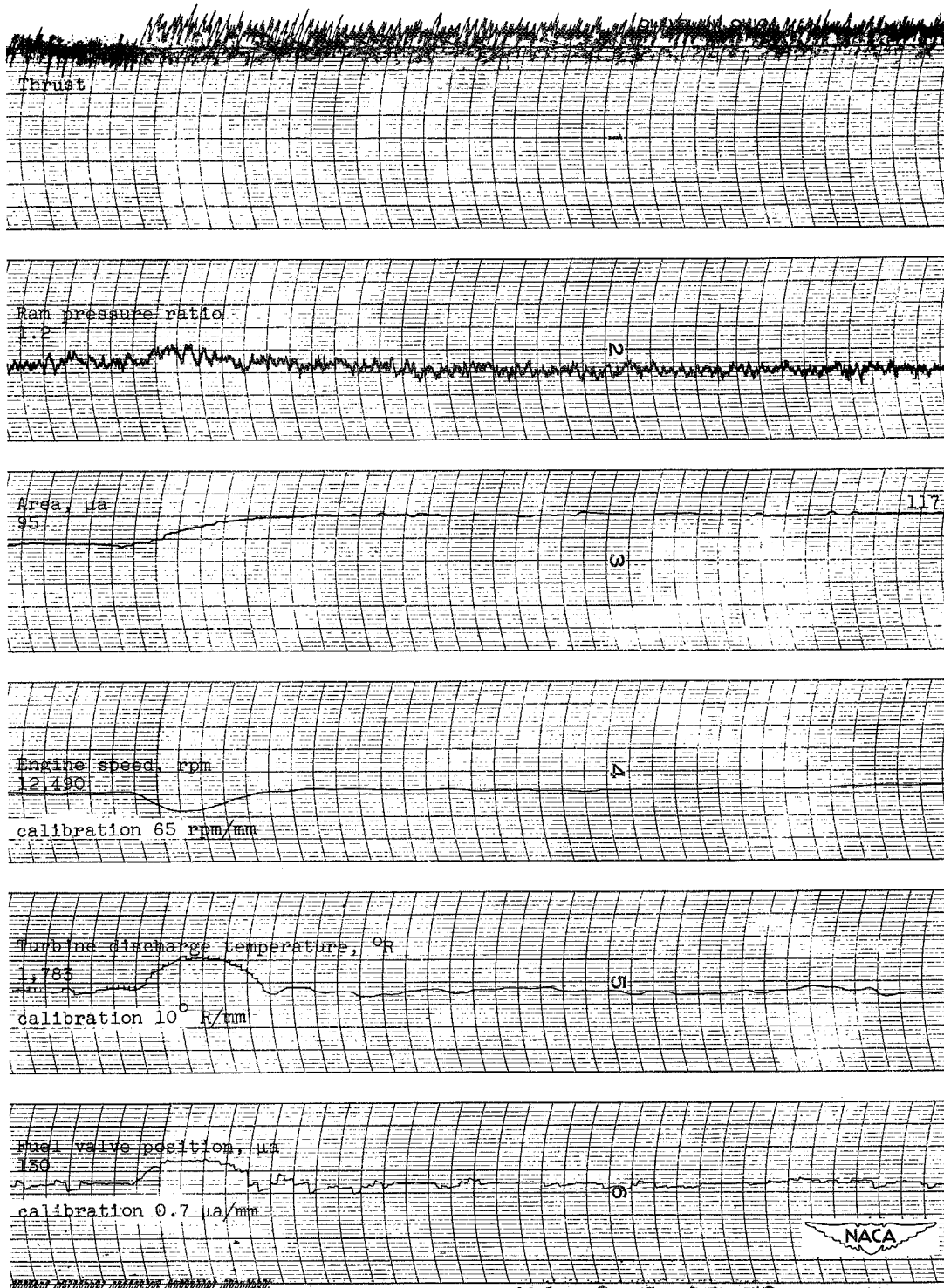


Figure 8. - Transient operation of automatically controlled engine with afterburner. Throttle position, 106° to 110° ; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

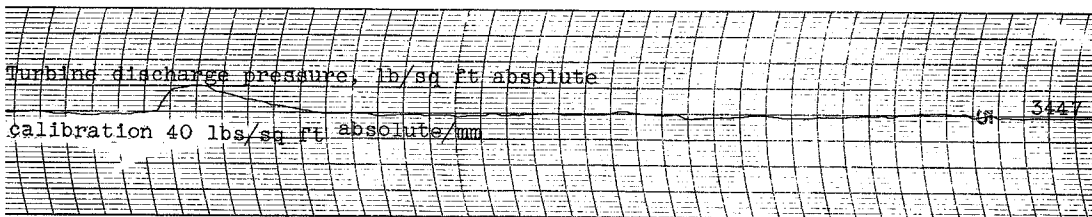
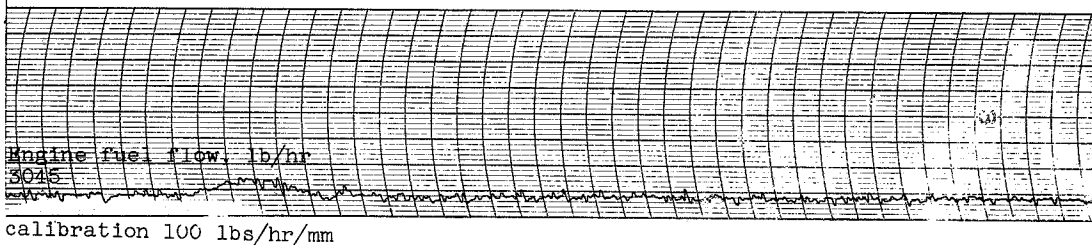
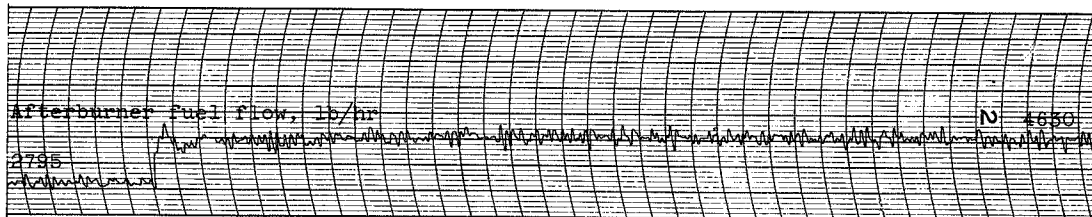
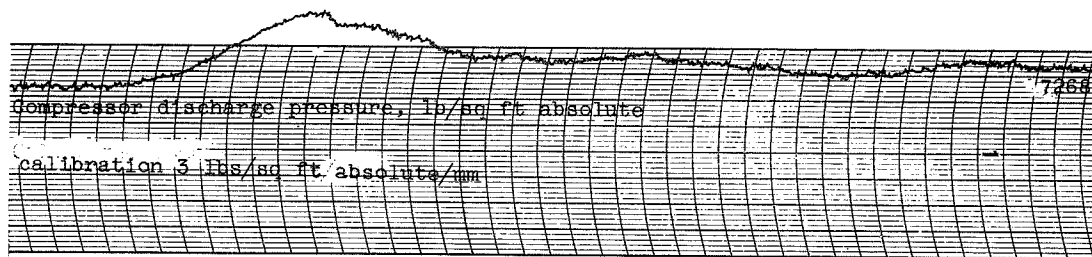


Figure 8. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 106° to 110°; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

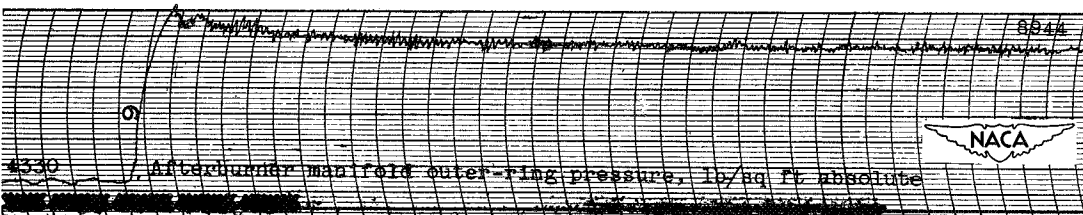
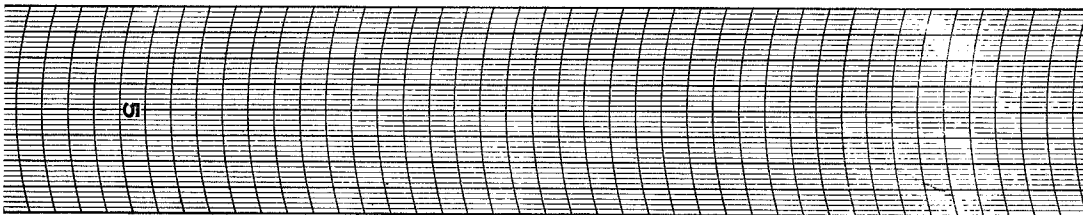
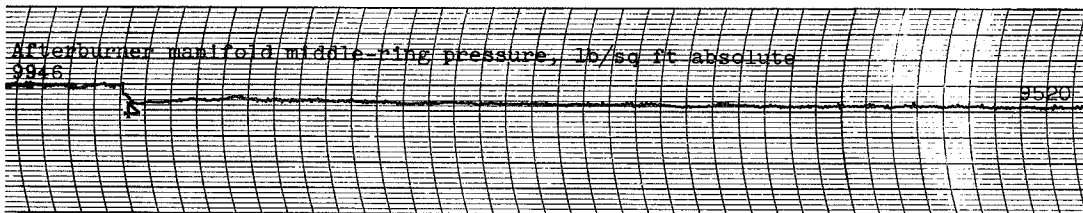
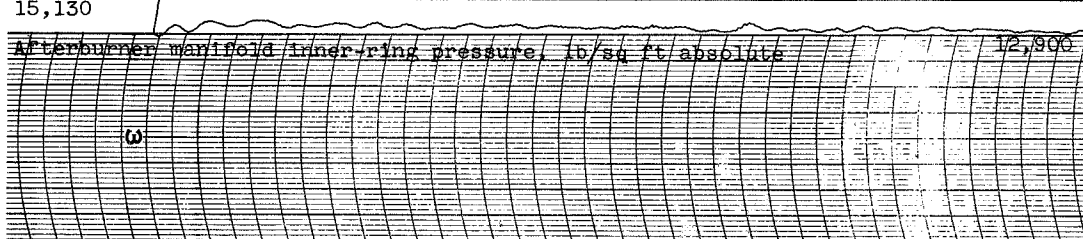
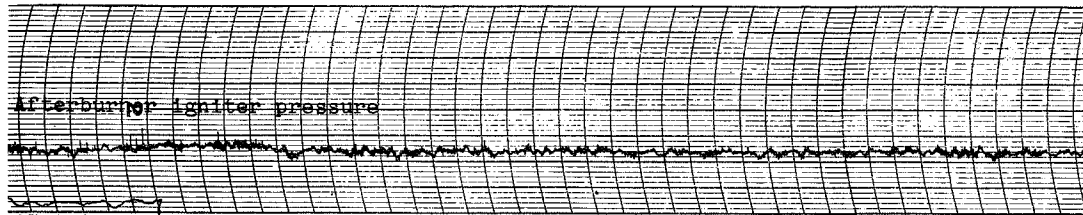
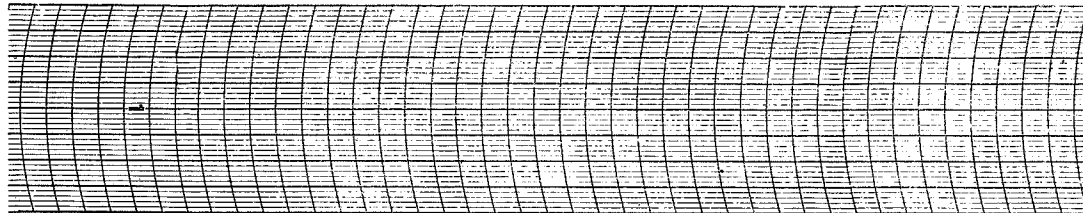


Figure 8. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 106° to 110°; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

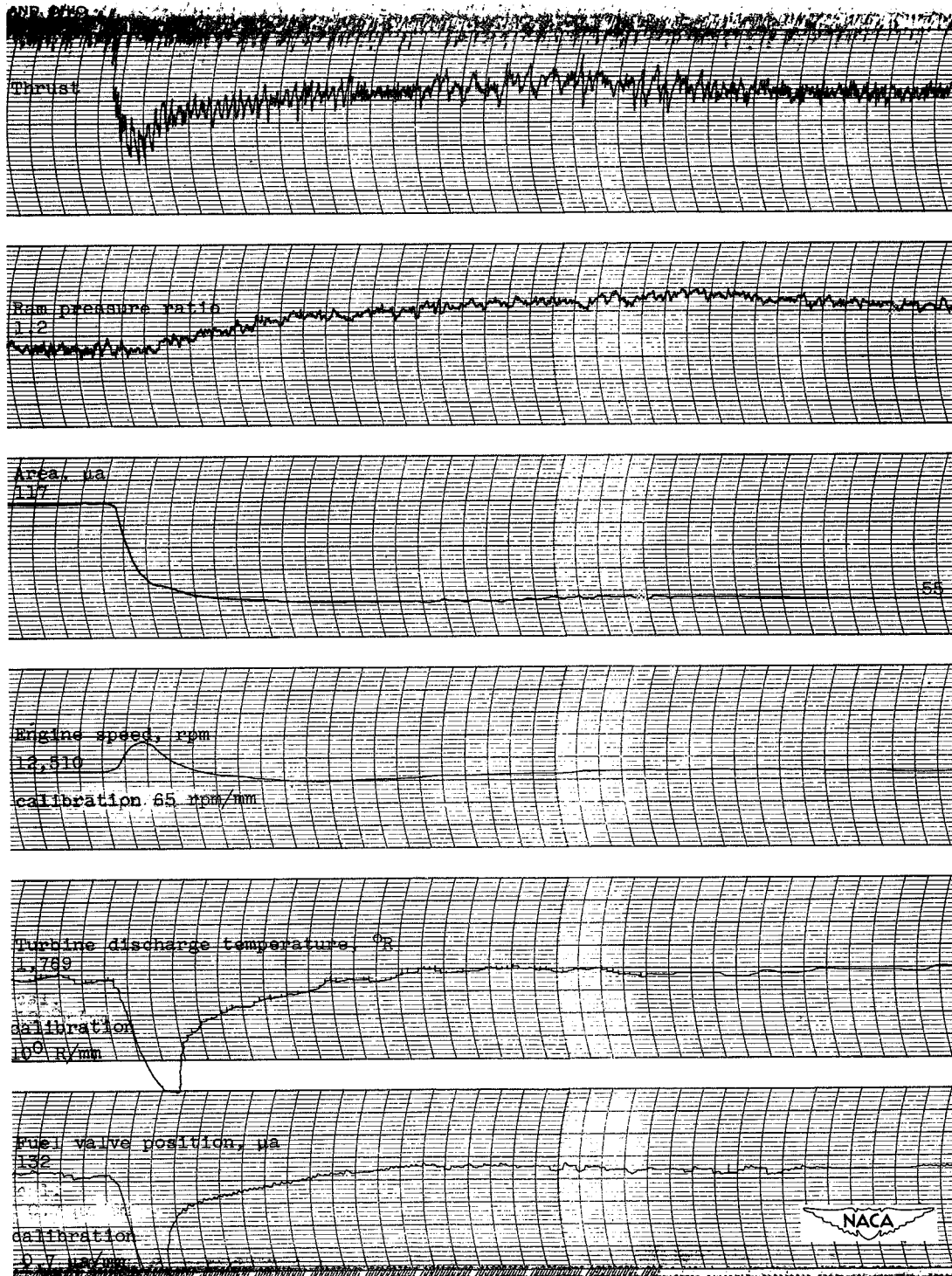


Figure 9. - Transient operation of automatically controlled engine with after-burner. Throttle position, 110° to 90°; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

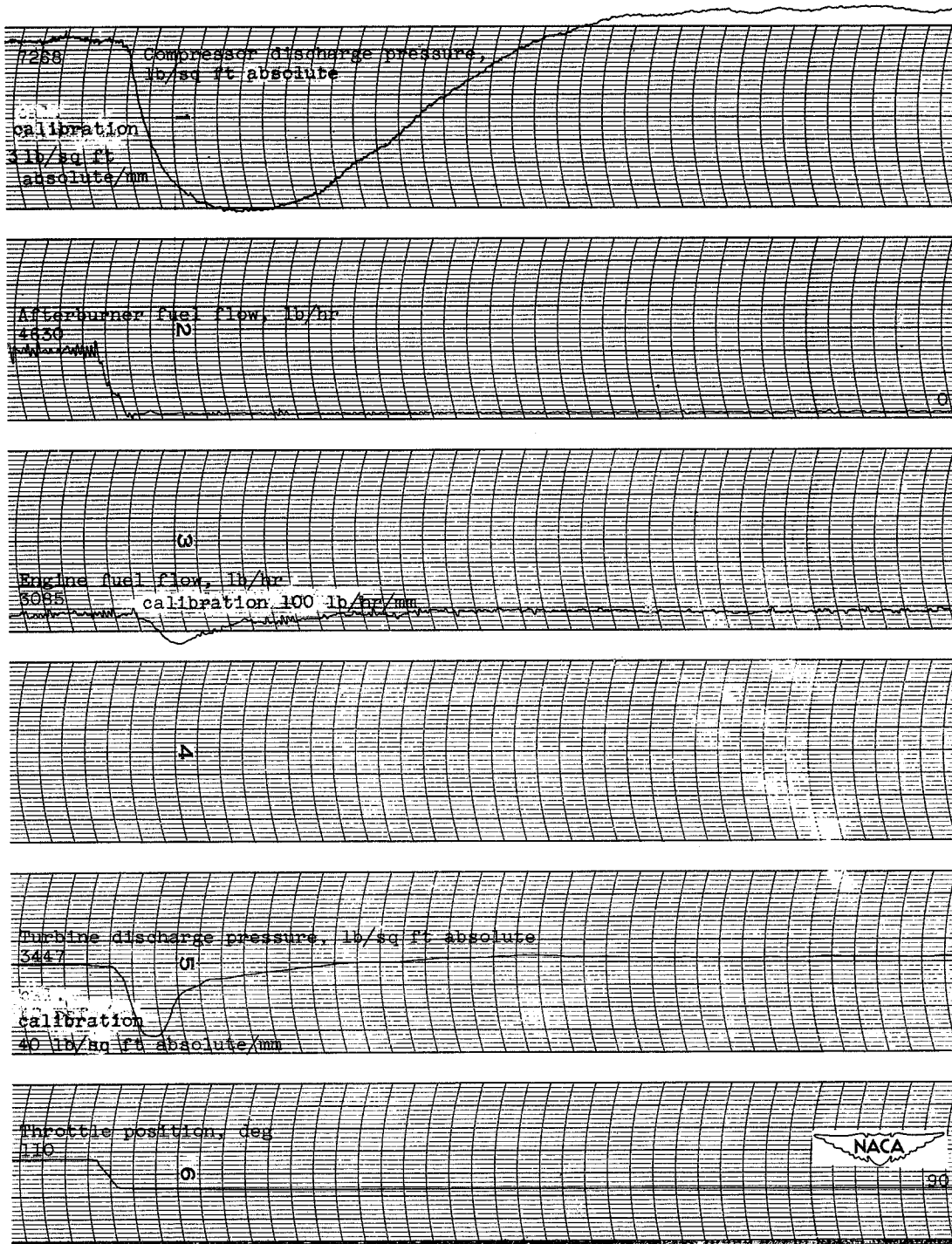


Figure 9. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 90°; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

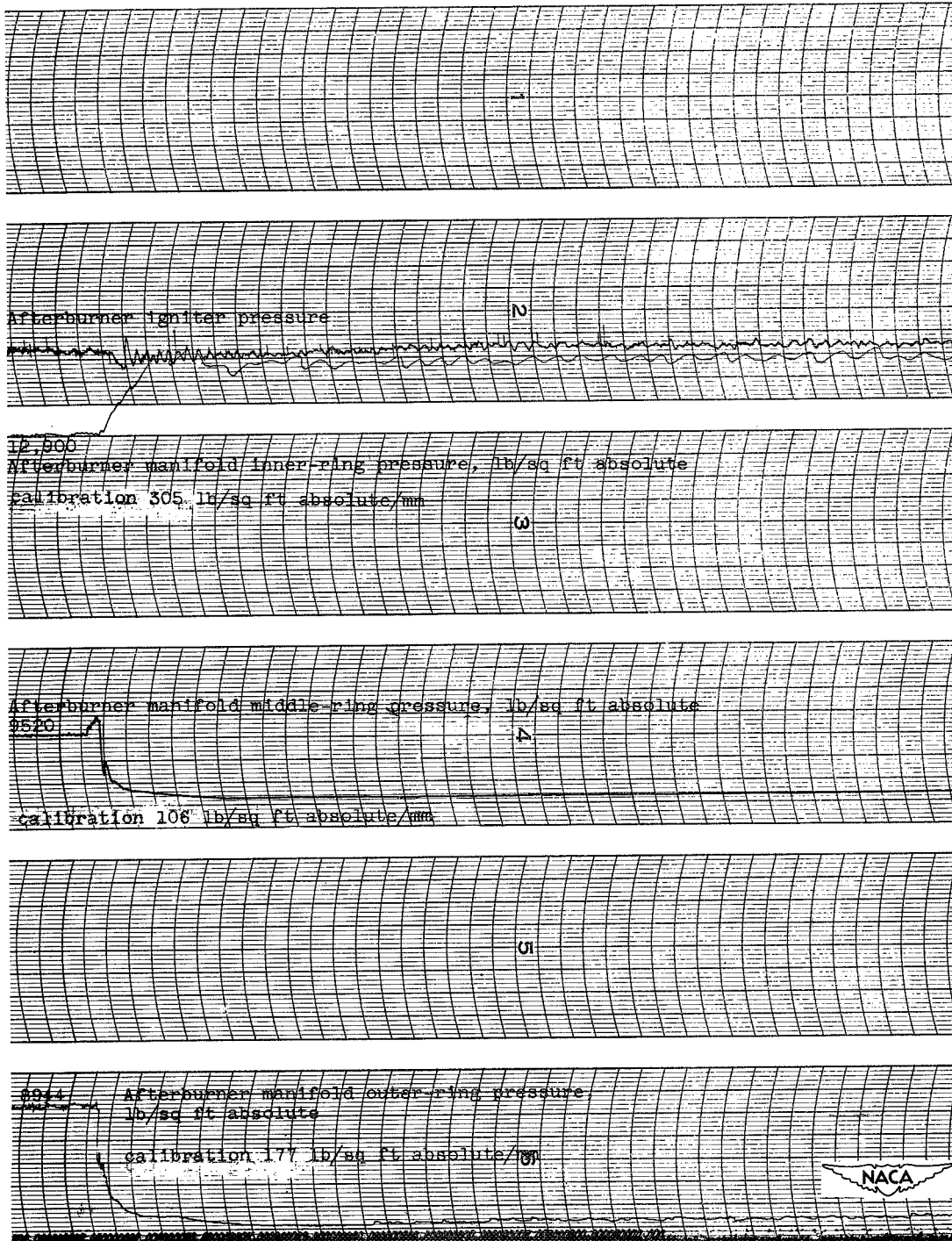


Figure 9. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 90°; altitude, 10,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

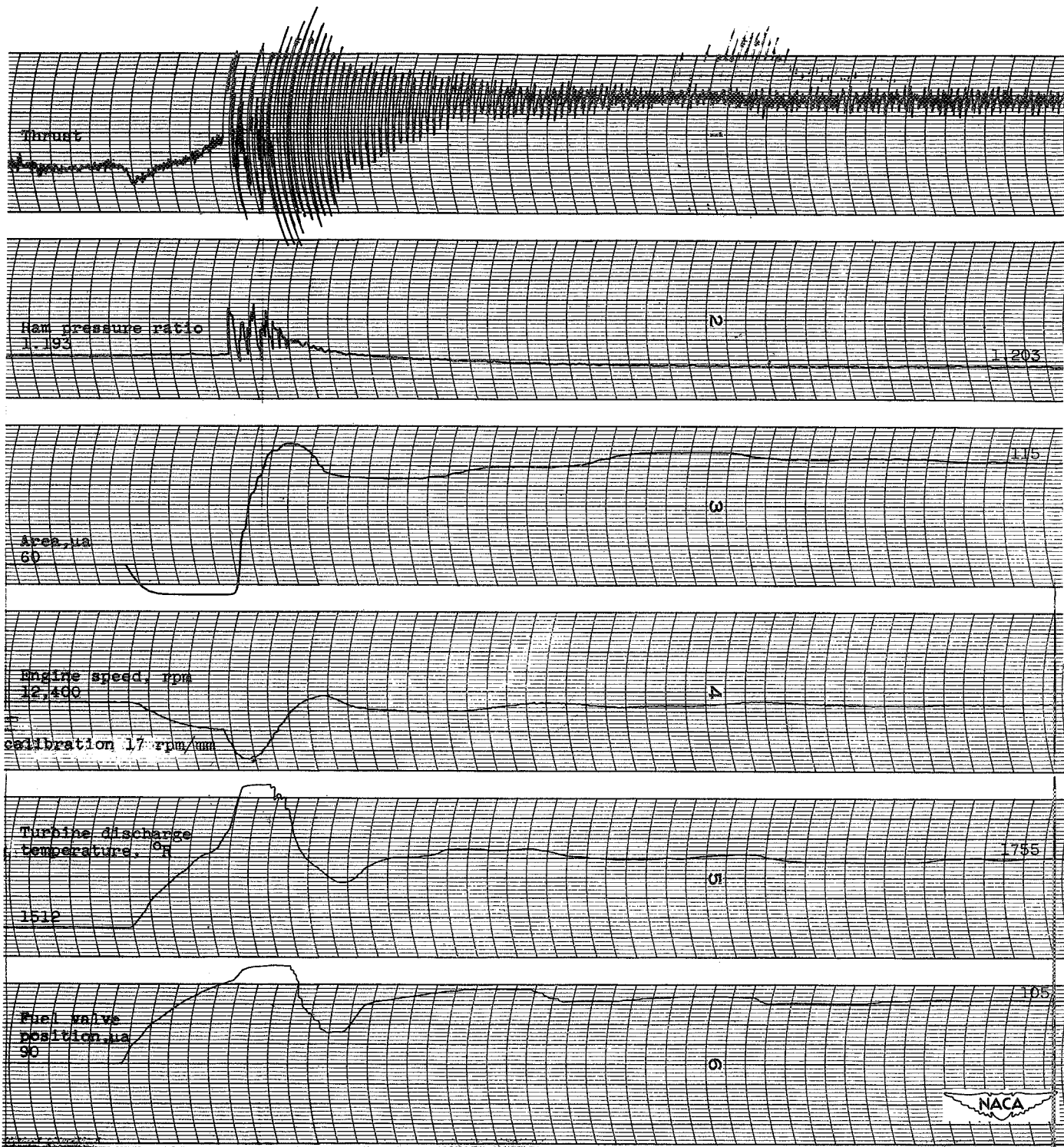


Figure 10. - Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 111°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

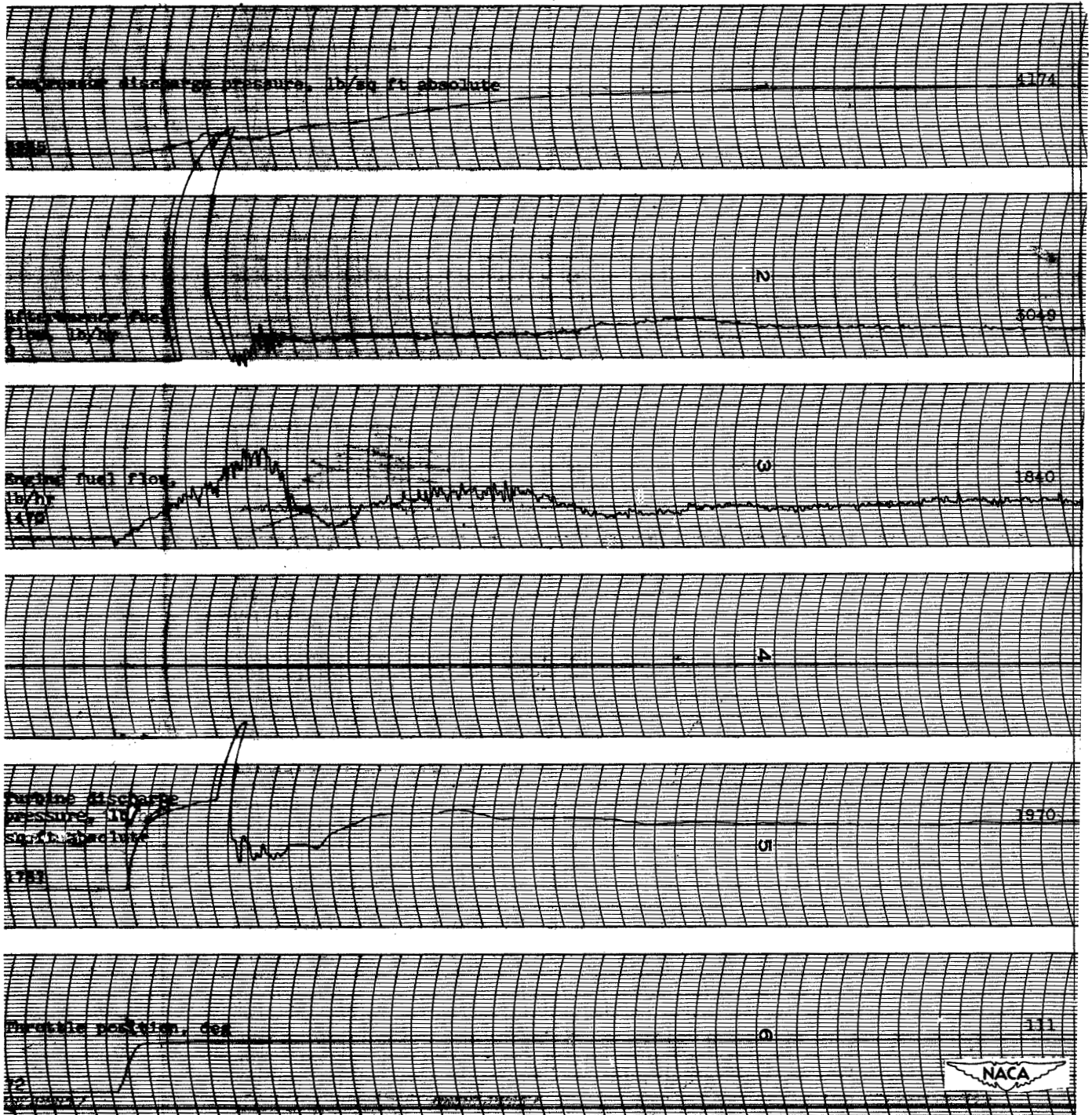


Figure 10. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 111°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

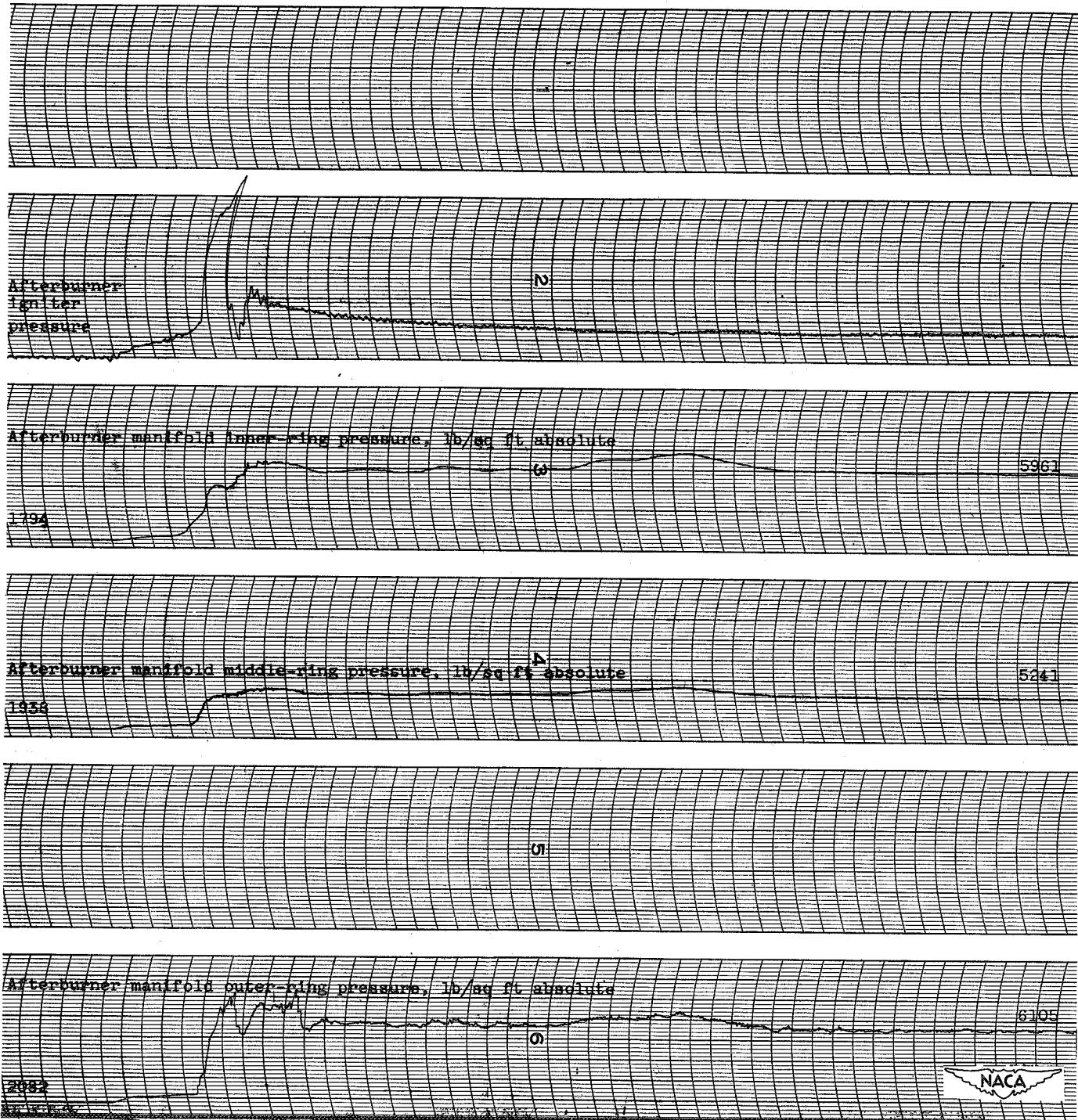


Figure 10. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 111°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

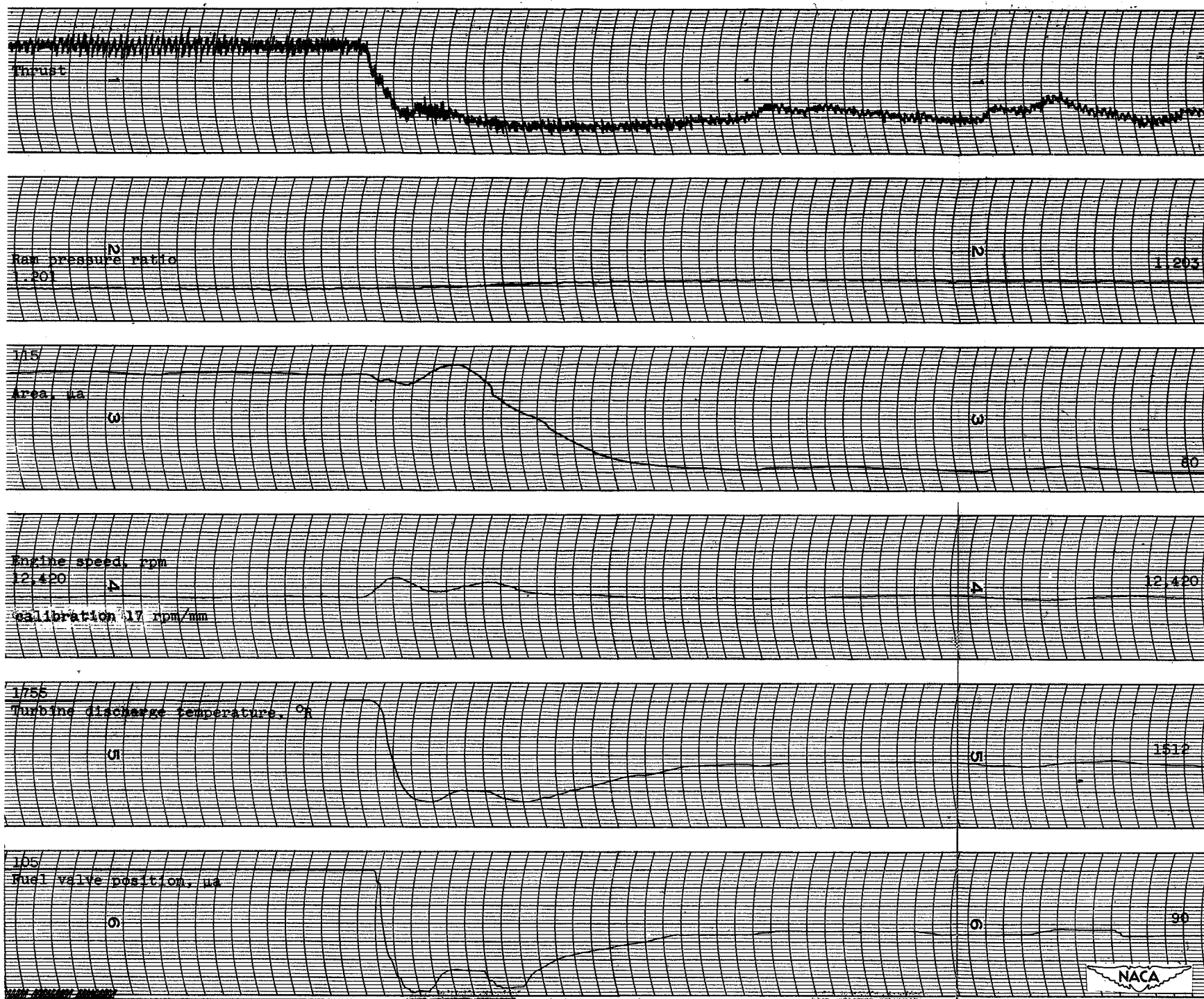


Figure 11. - Transient operation of automatically controlled engine with afterburner. Throttle position, 111° to 72° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

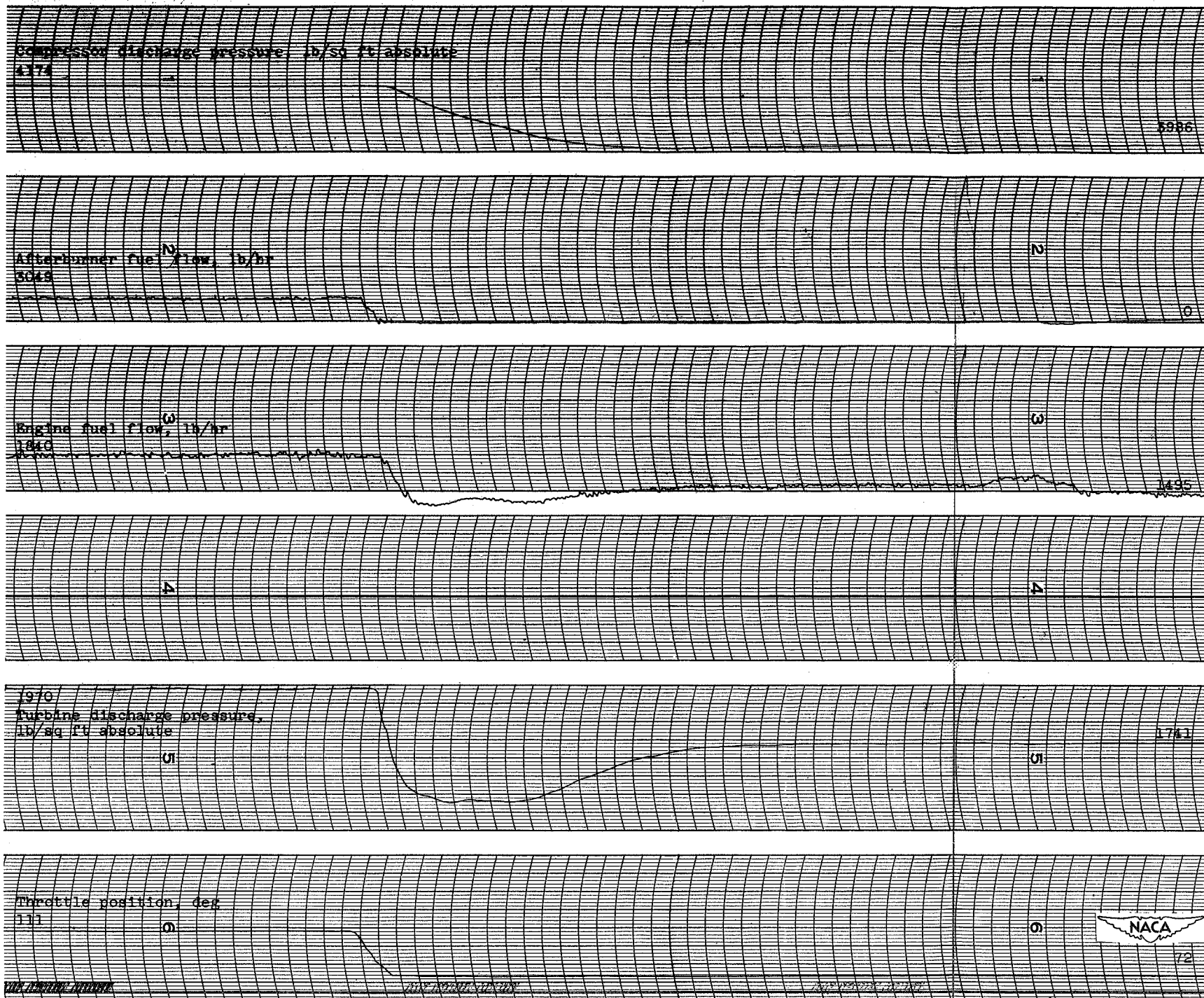


Figure 11. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 111° to 72° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

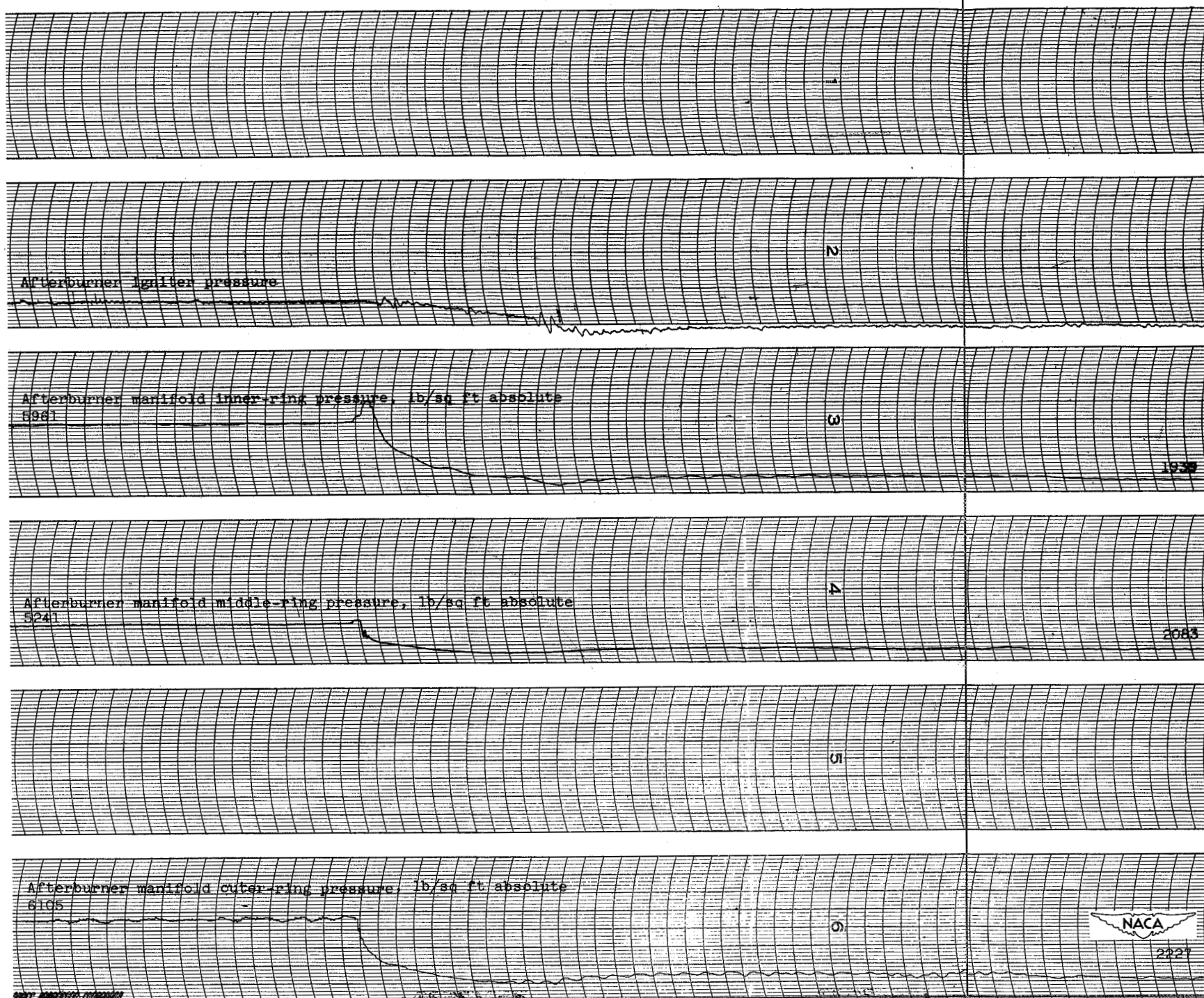


Figure 11. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 111° to 72° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

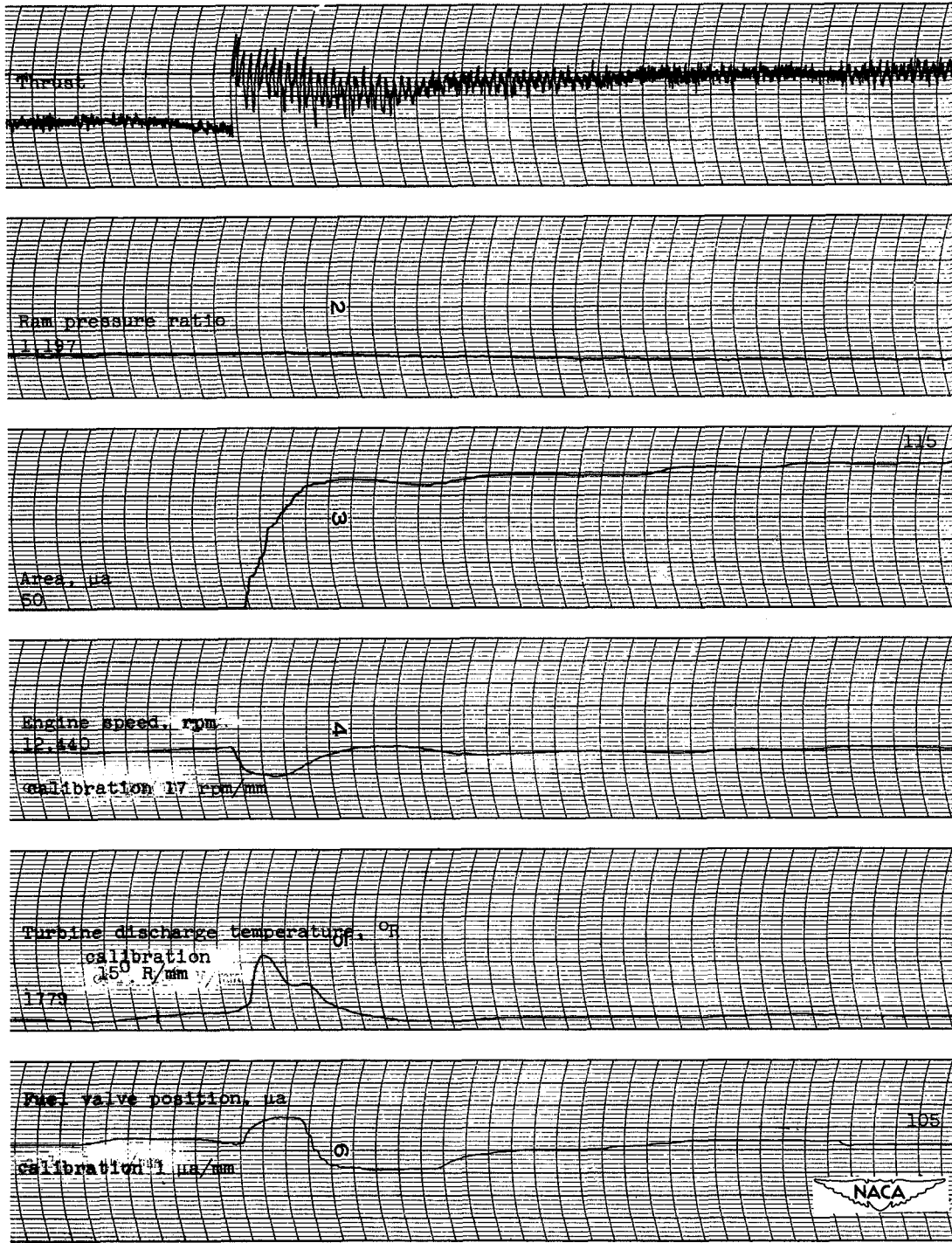


Figure 12. - Transient operation of automatically controlled engine with afterburner. Throttle position, 83° to 111° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

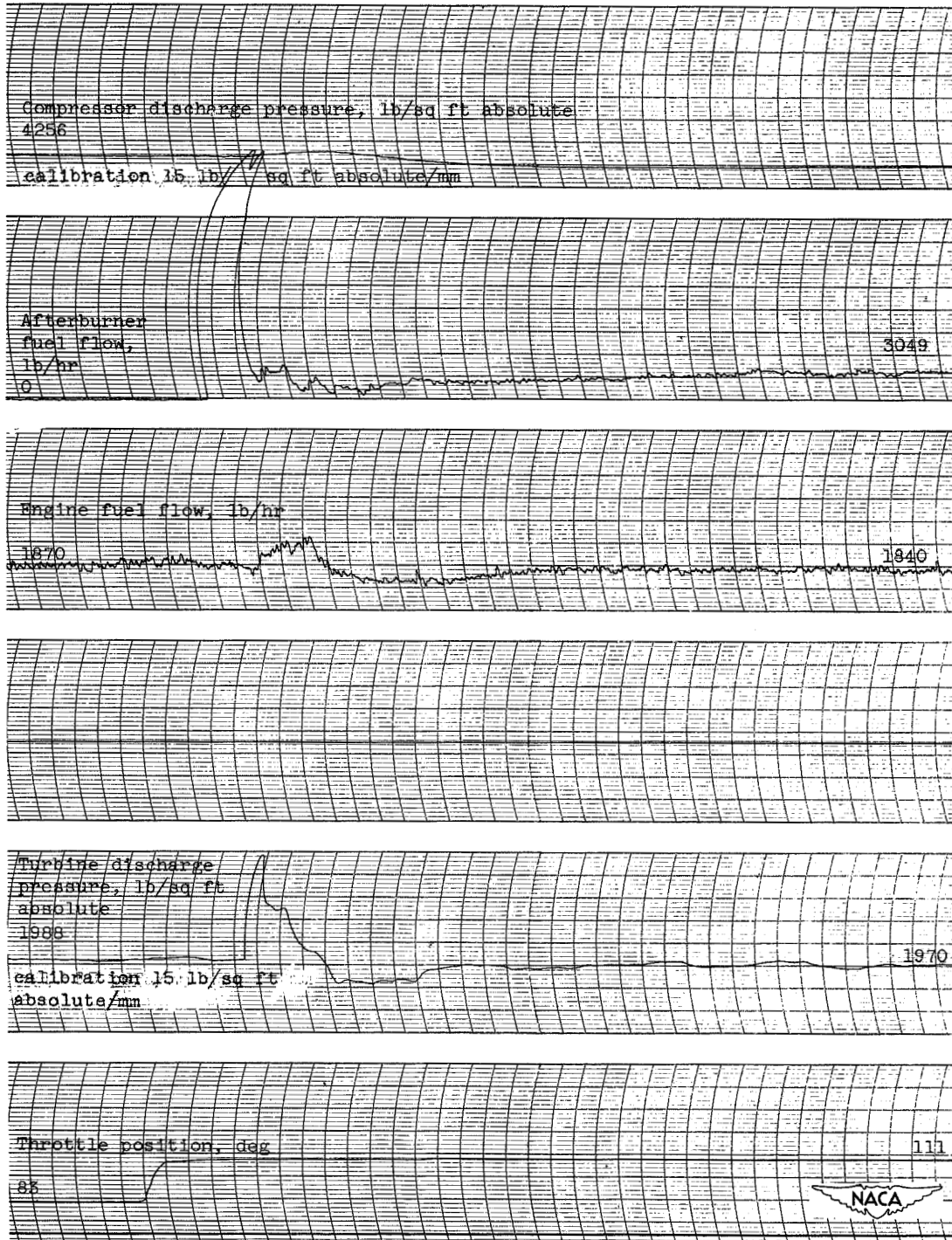


Figure 12. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 83° to 111°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

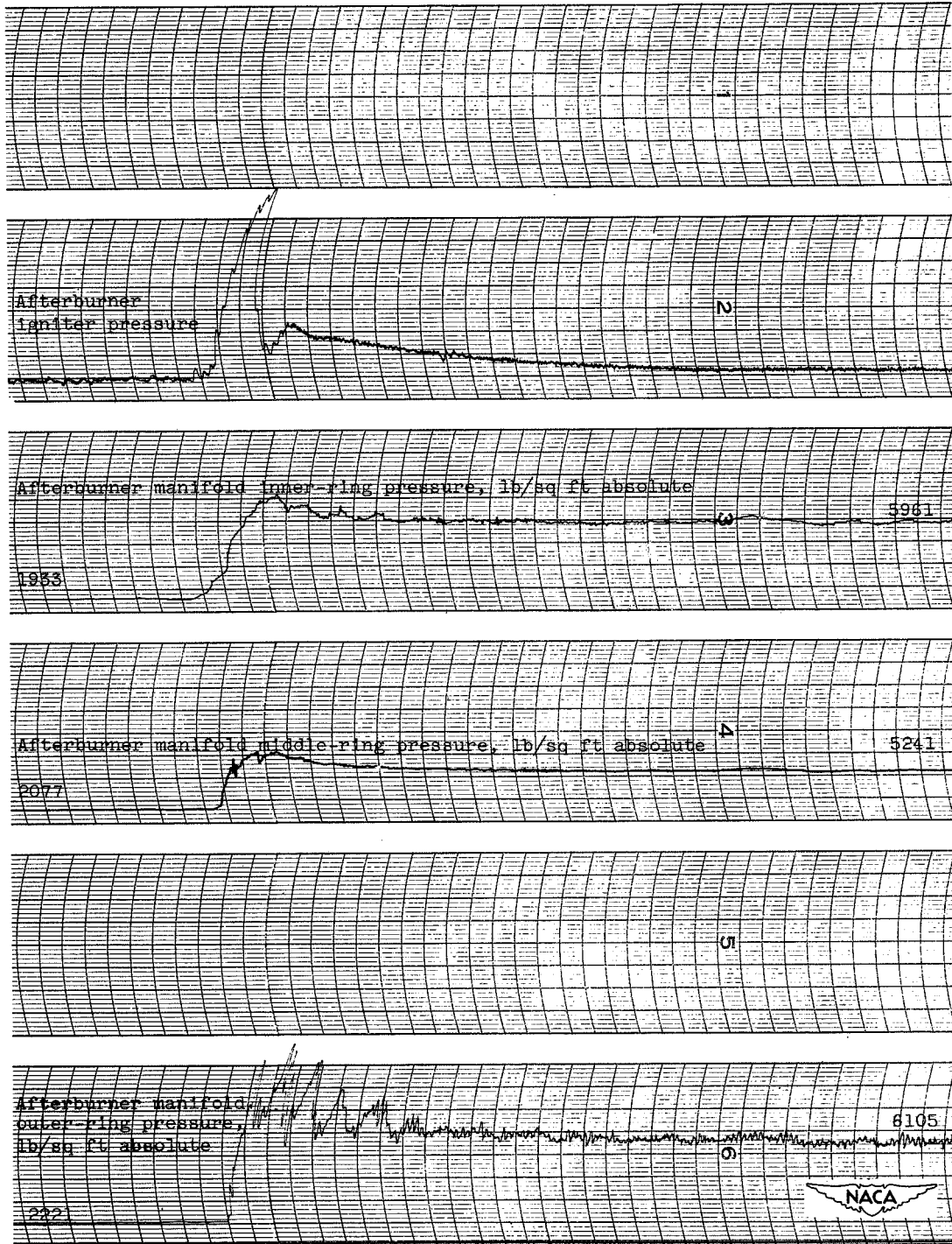


Figure 12. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 83° to 111°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

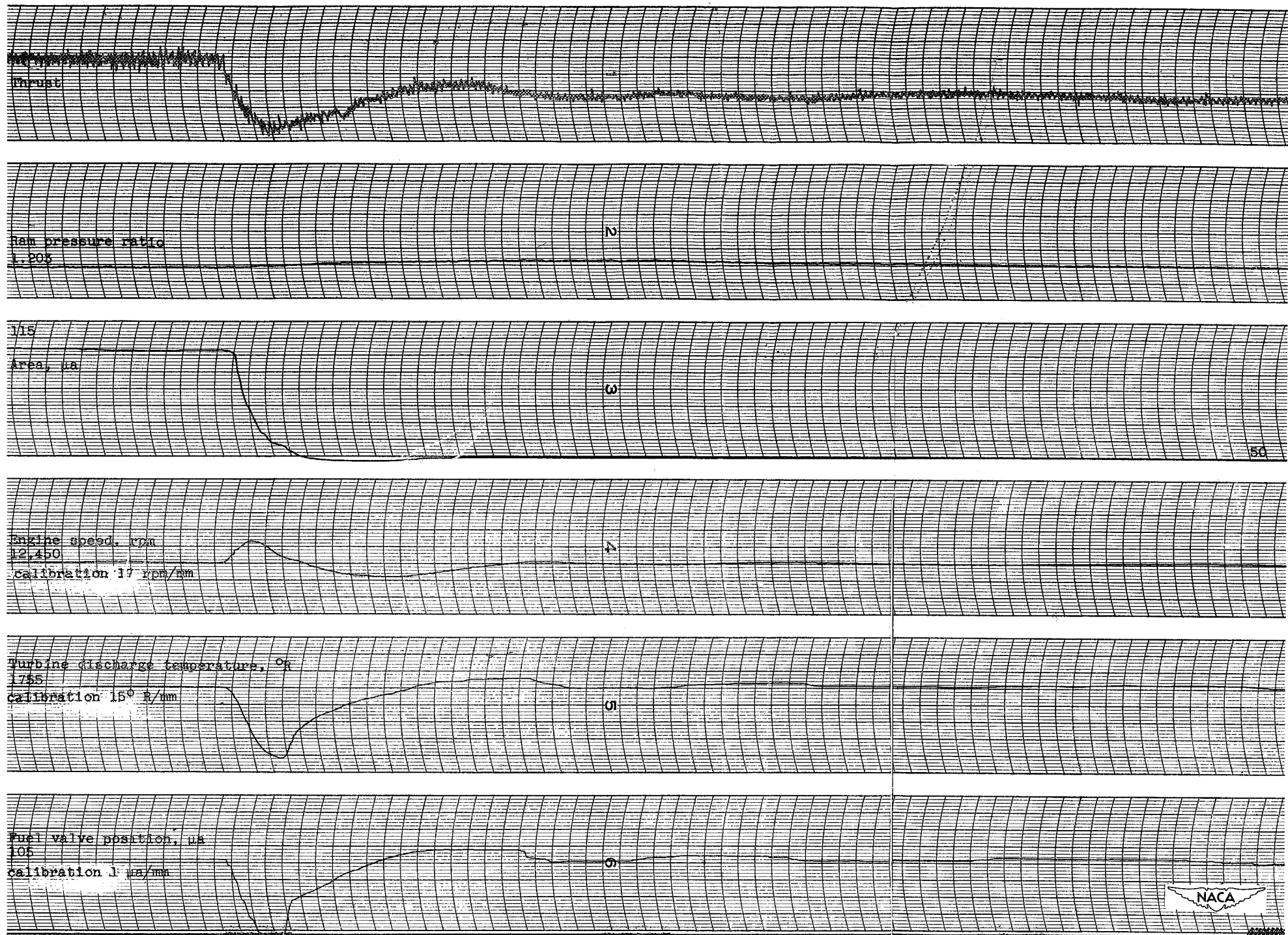


Figure 13. - Transient operation of automatically controlled engine with afterburner. Throttle position, 111° to 83° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

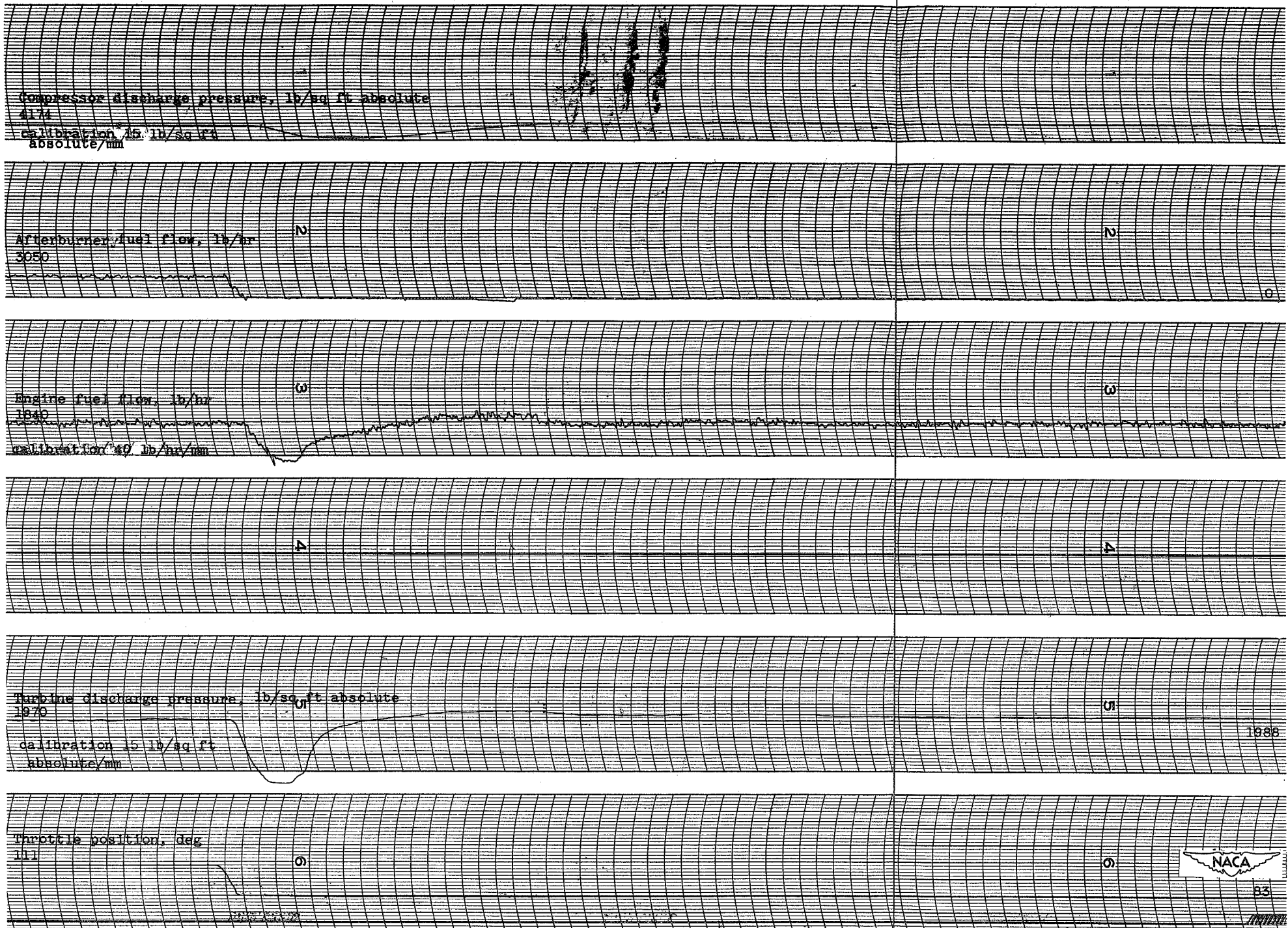


Figure 13. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 111° to 83° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

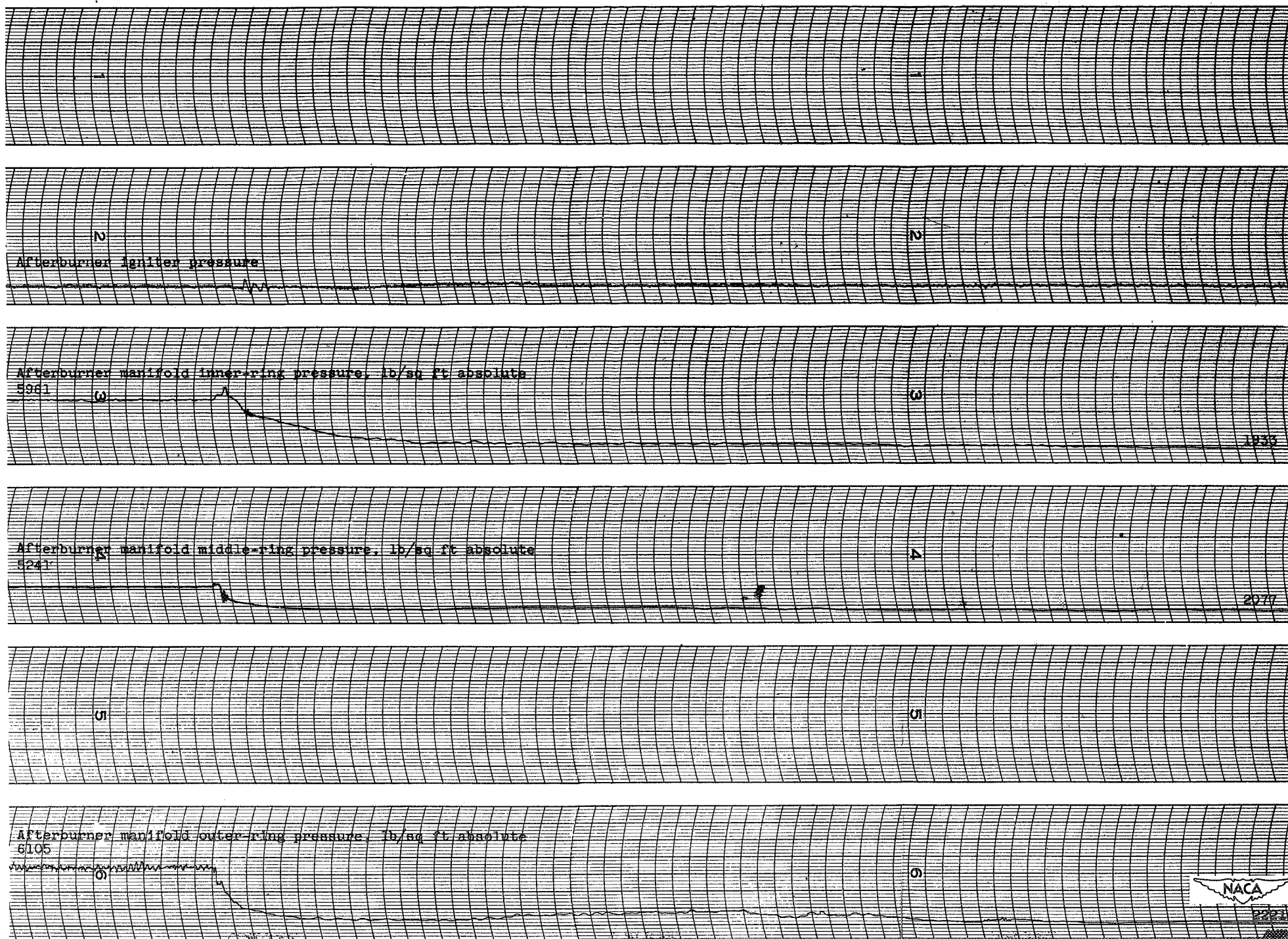


Figure 13. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 111° to 83° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

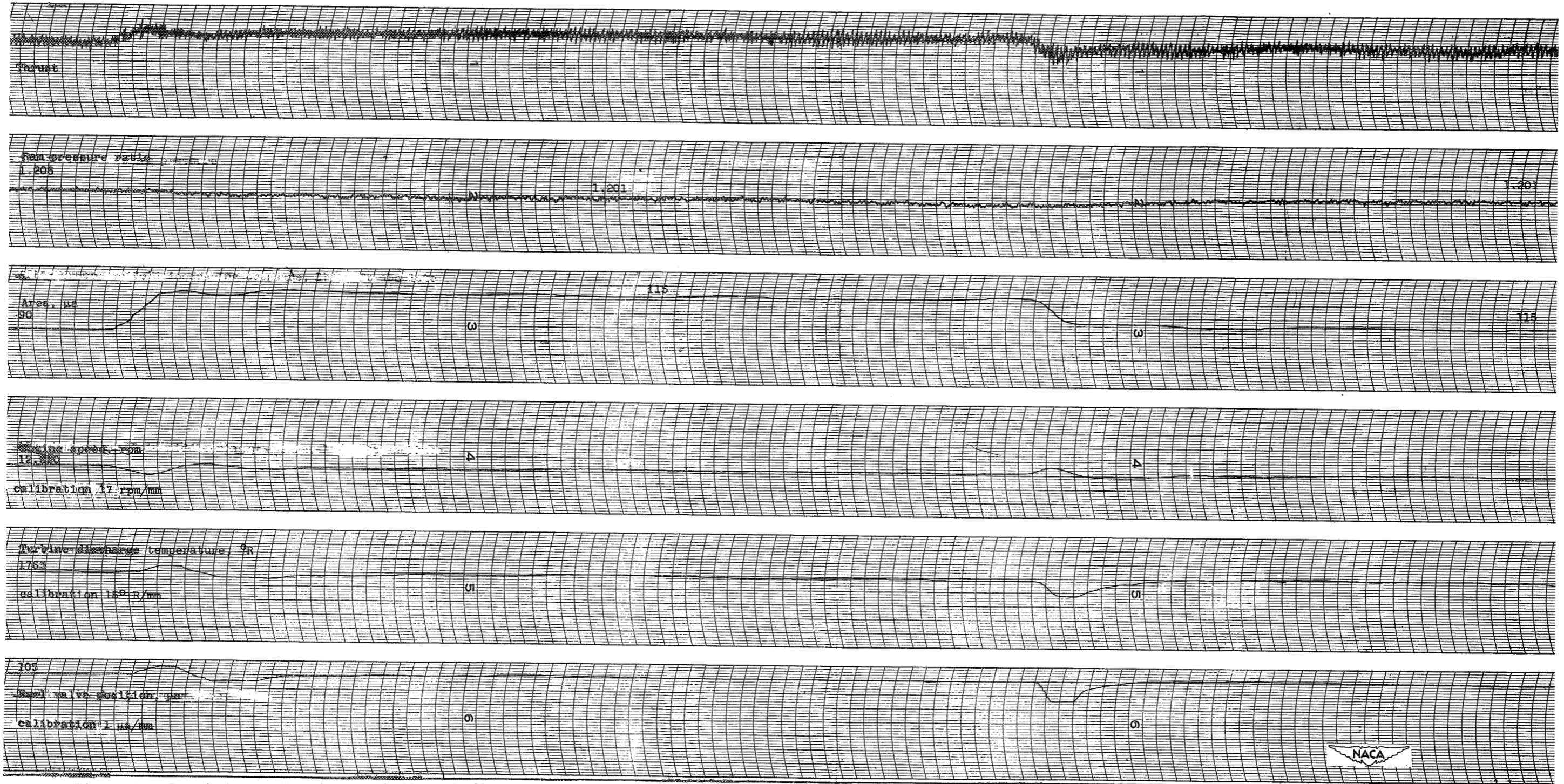


Figure 14. - Transient operation of automatically controlled engine with afterburner. Throttle position, 96° to 111° and 111° to 96°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

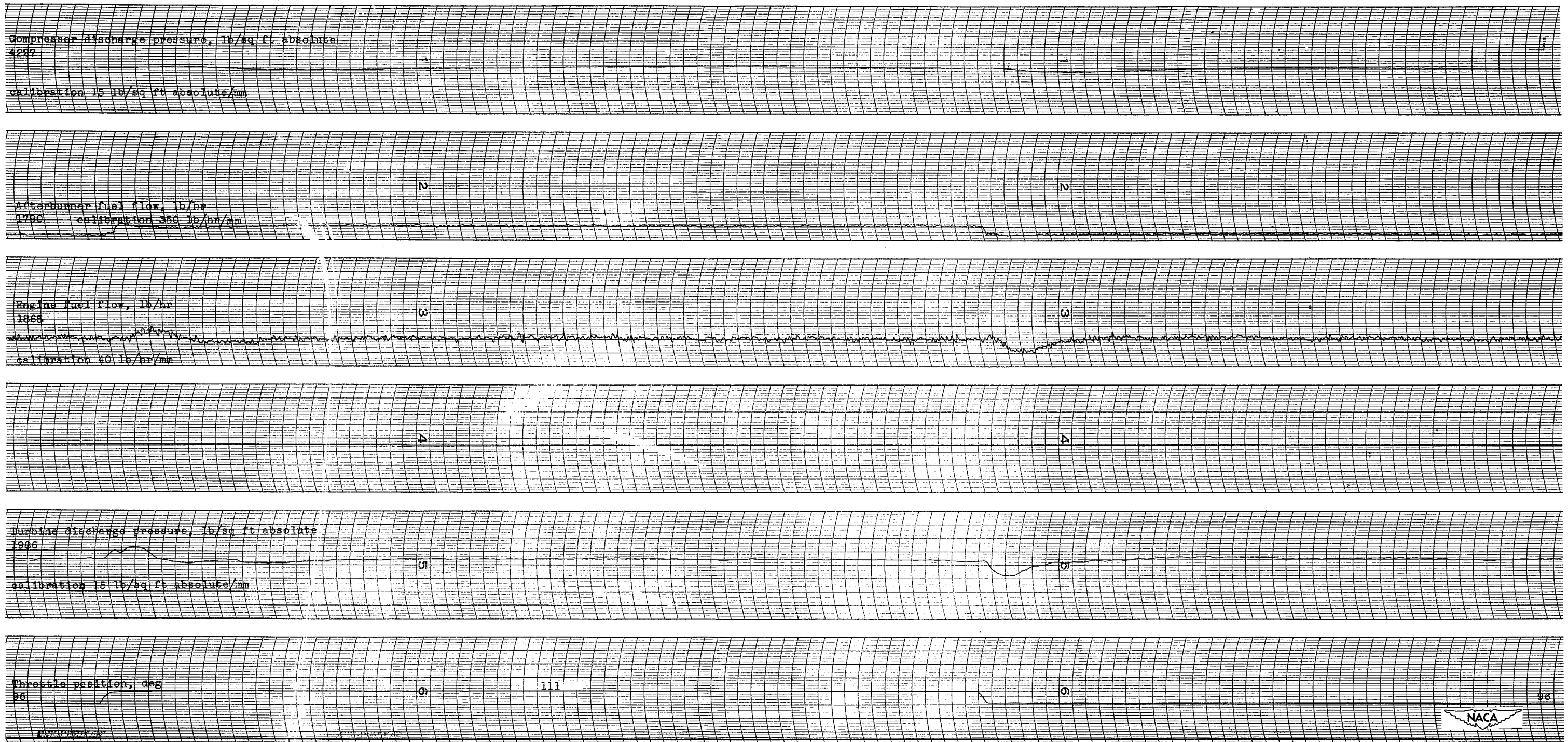


Figure 14. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 96° to 111° and 111° to 96°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

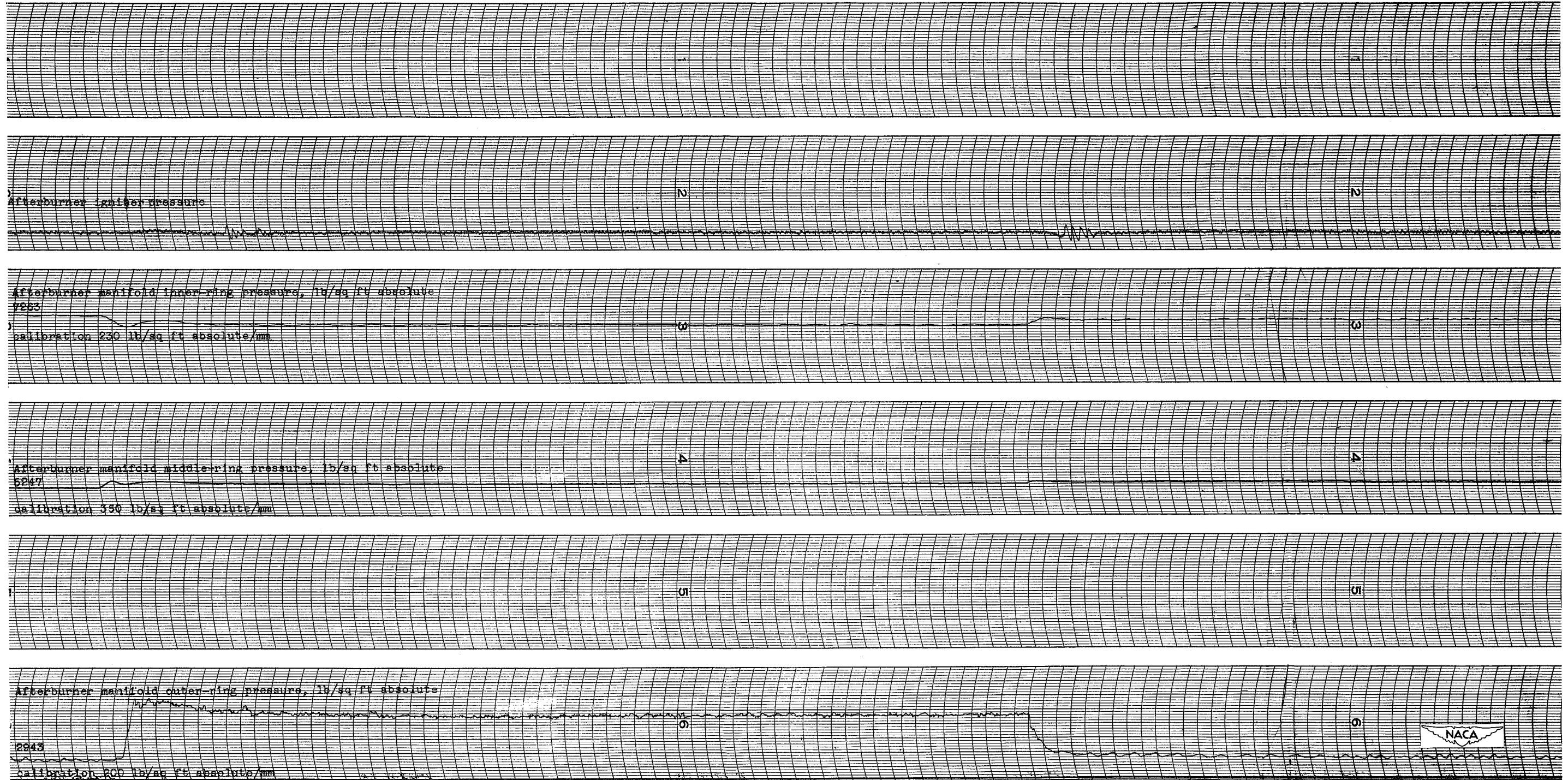


Figure 14. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 96° to 111° and 111° to 96°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

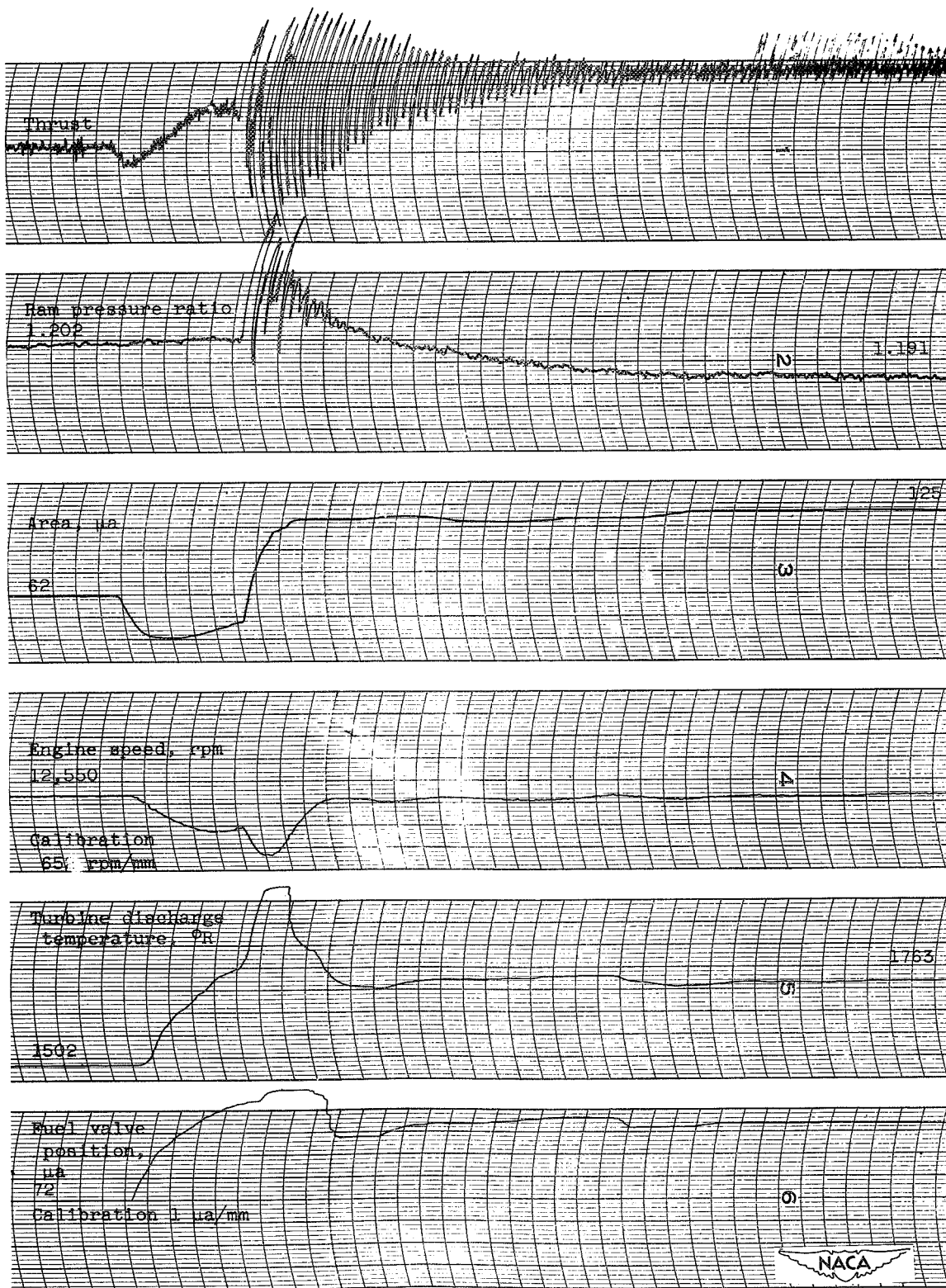


Figure 15. - Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 110°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

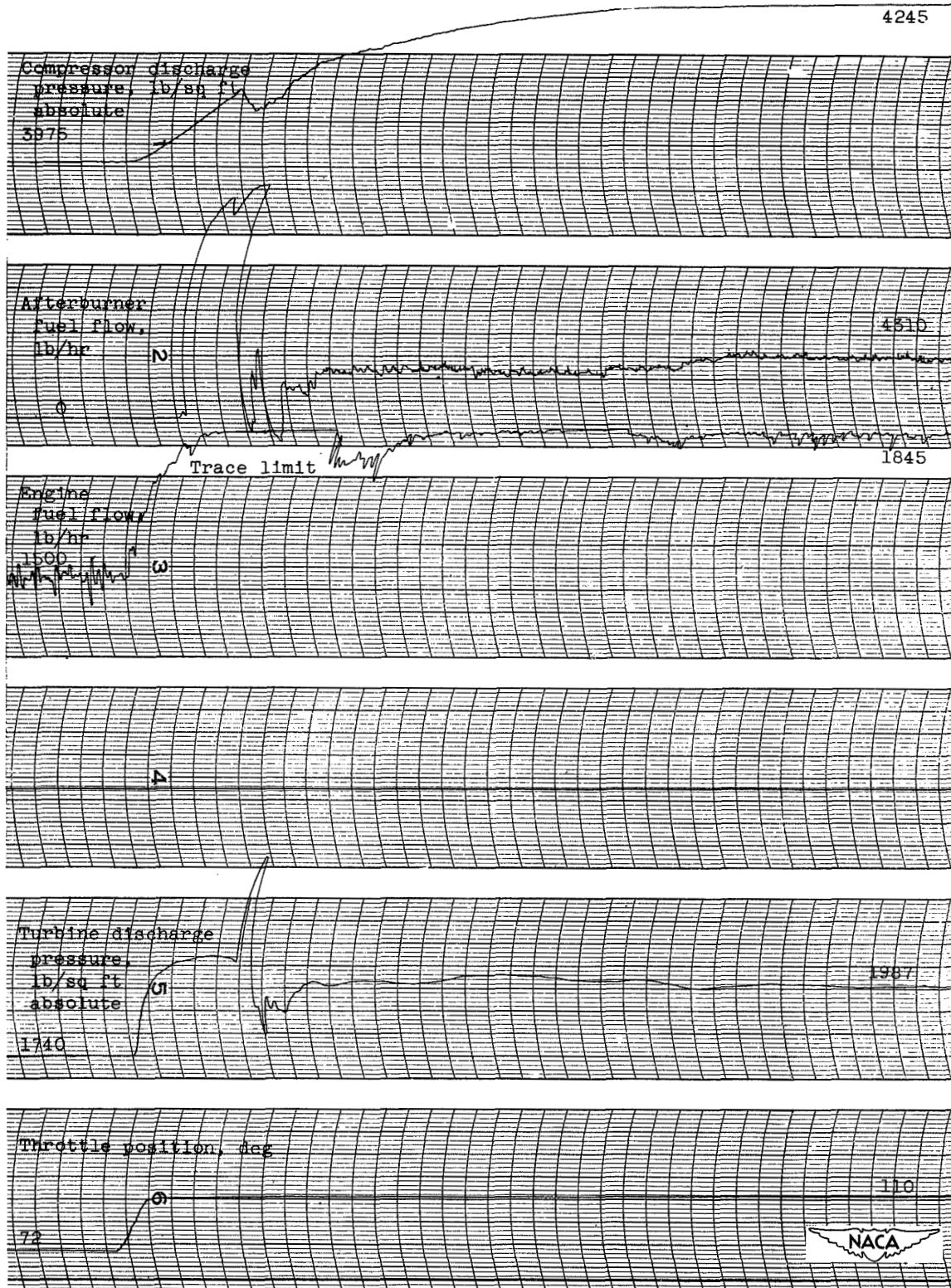


Figure 15. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 110°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

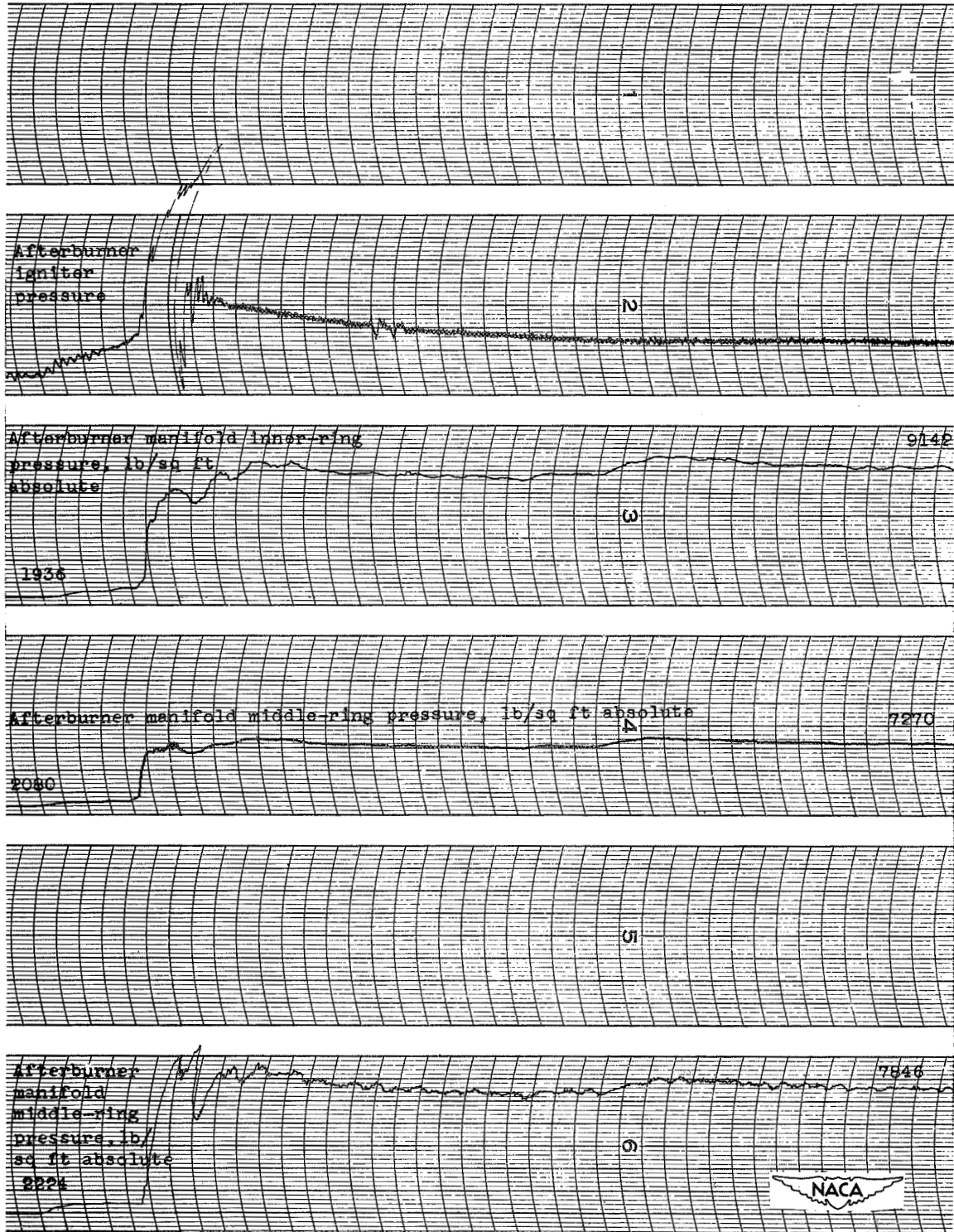


Figure 15. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 110° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

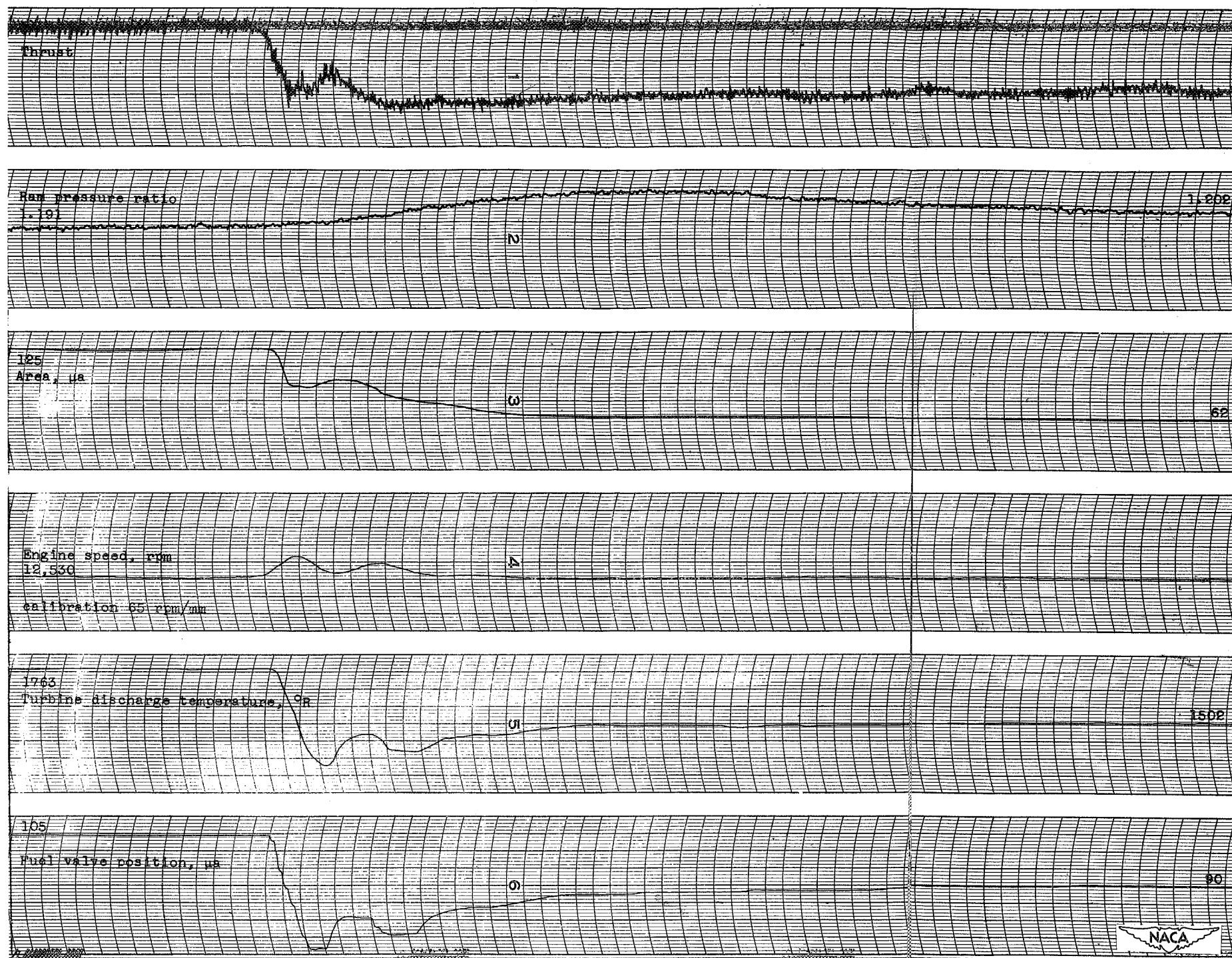


Figure 16. - Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 72° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

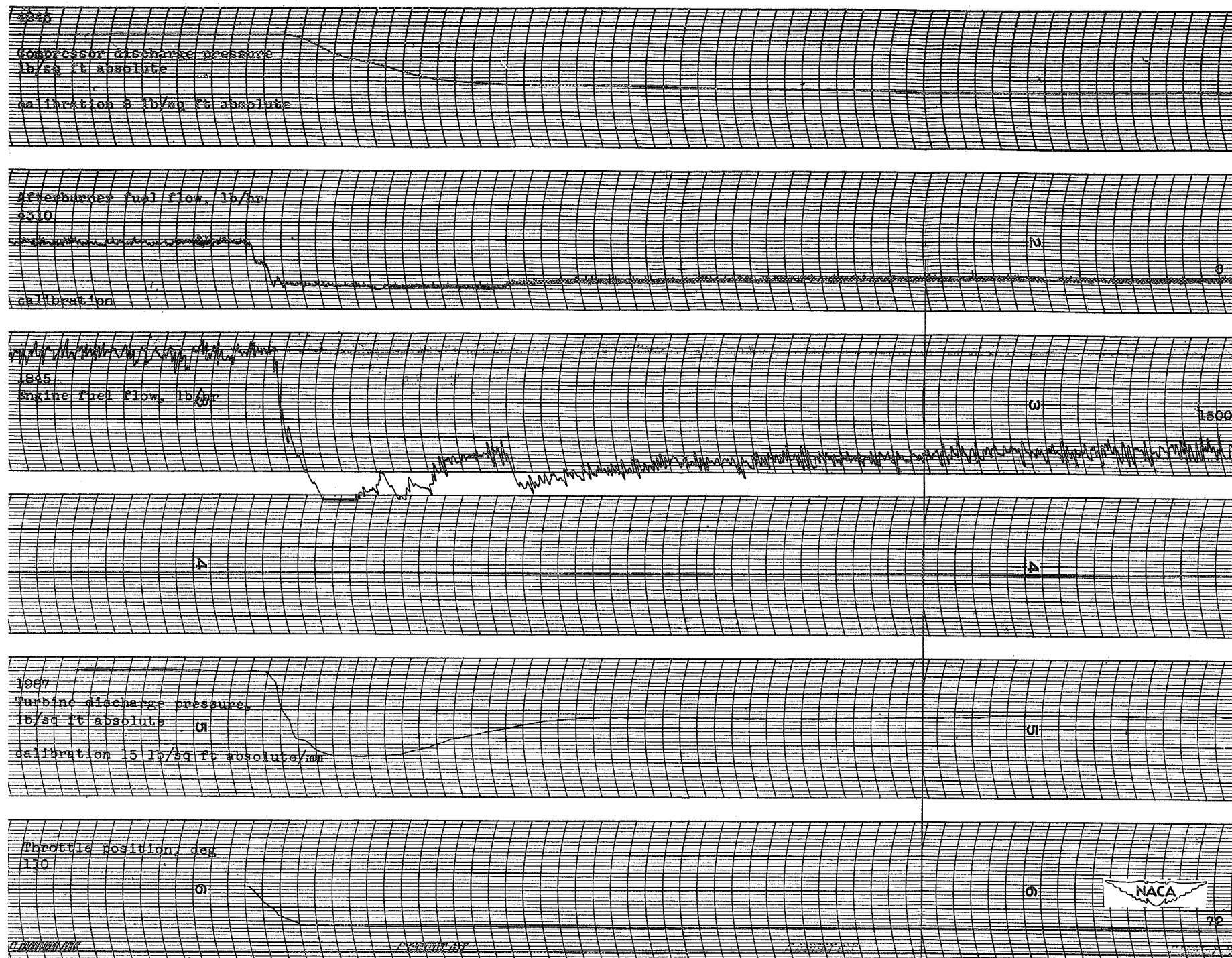


Figure 16. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 72° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

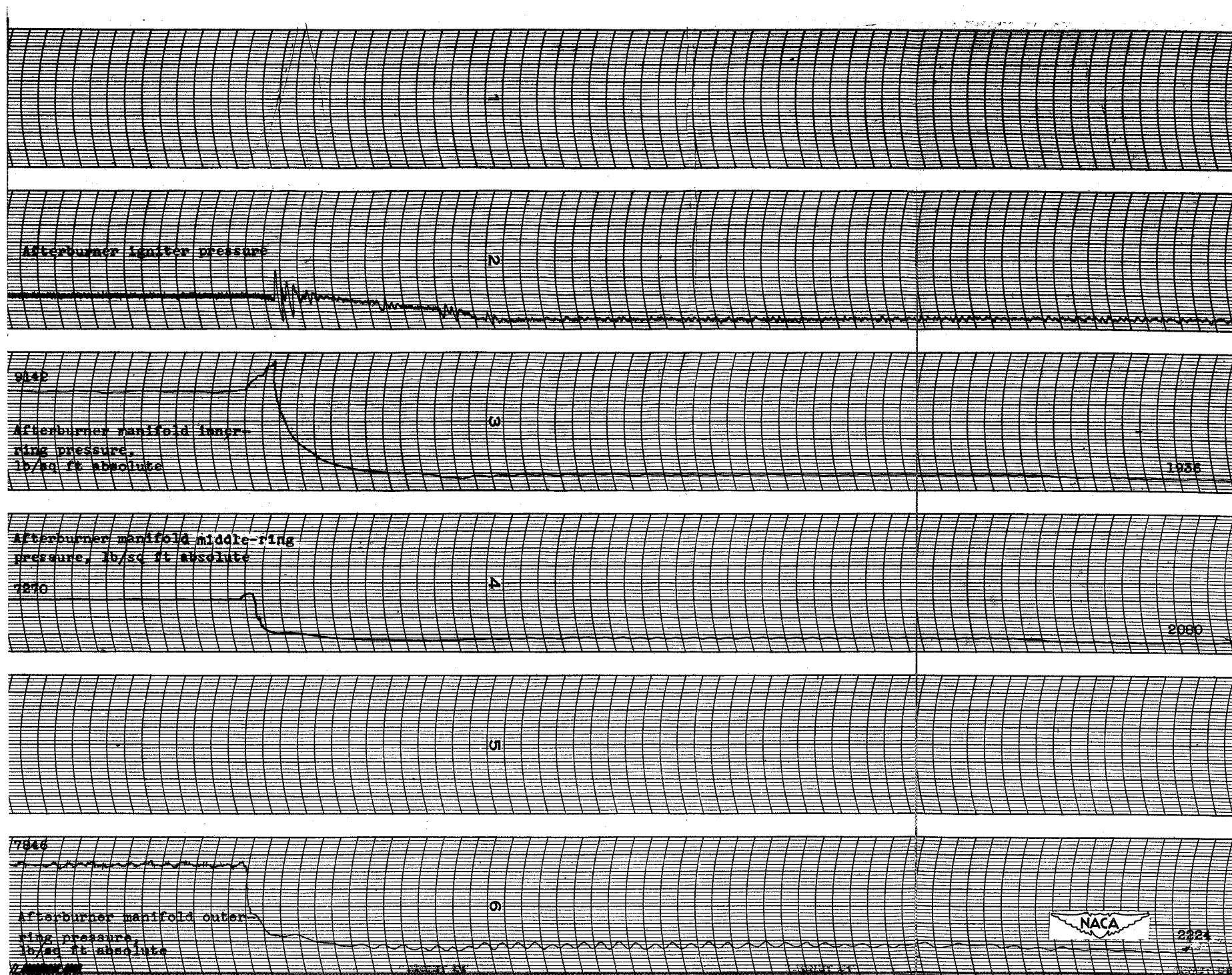


Figure 16. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 72° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

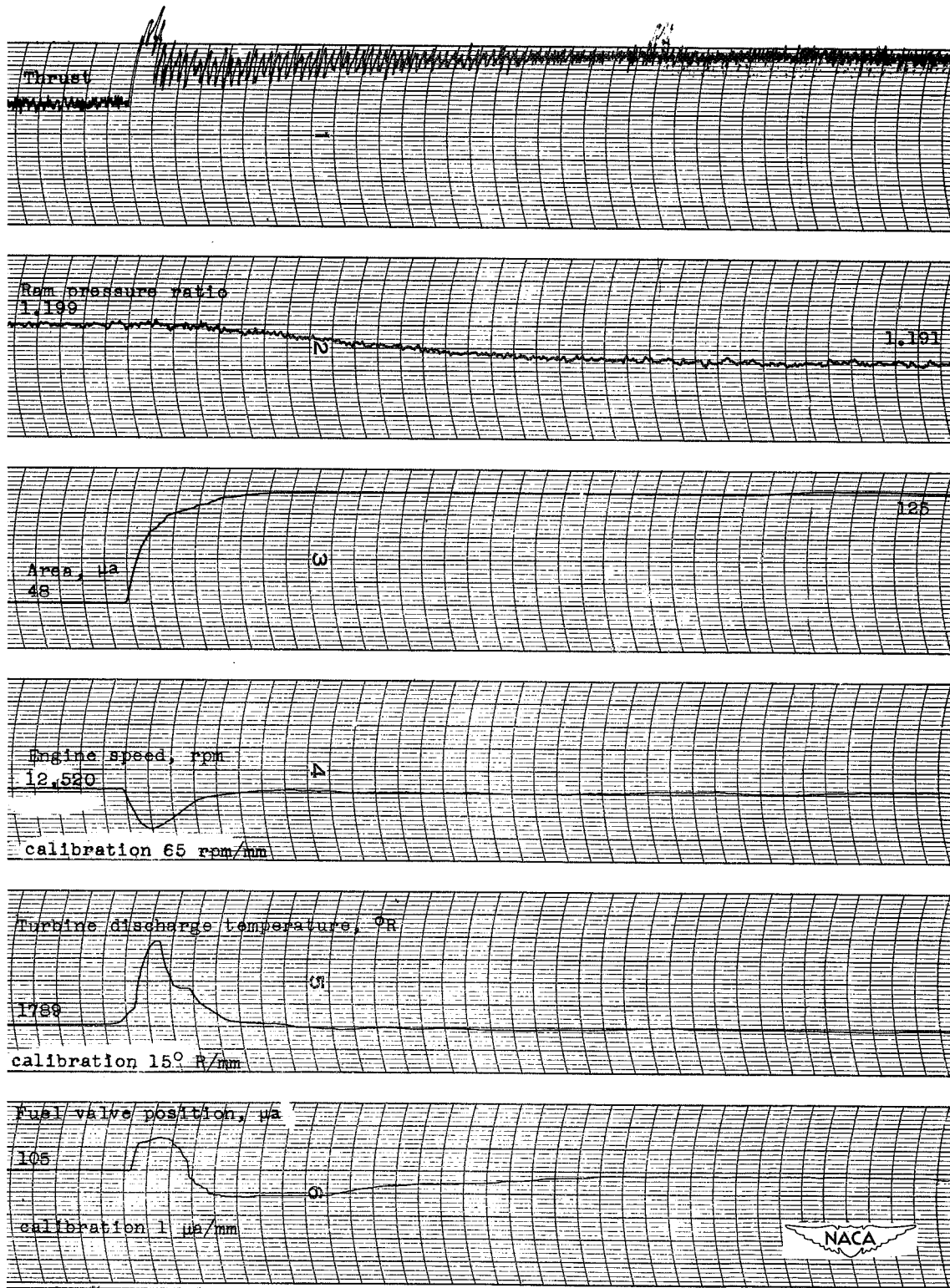


Figure 17. - Transient operation of automatically controlled engine with afterburner. Throttle position, 83 $^{\circ}$ to 110 $^{\circ}$; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

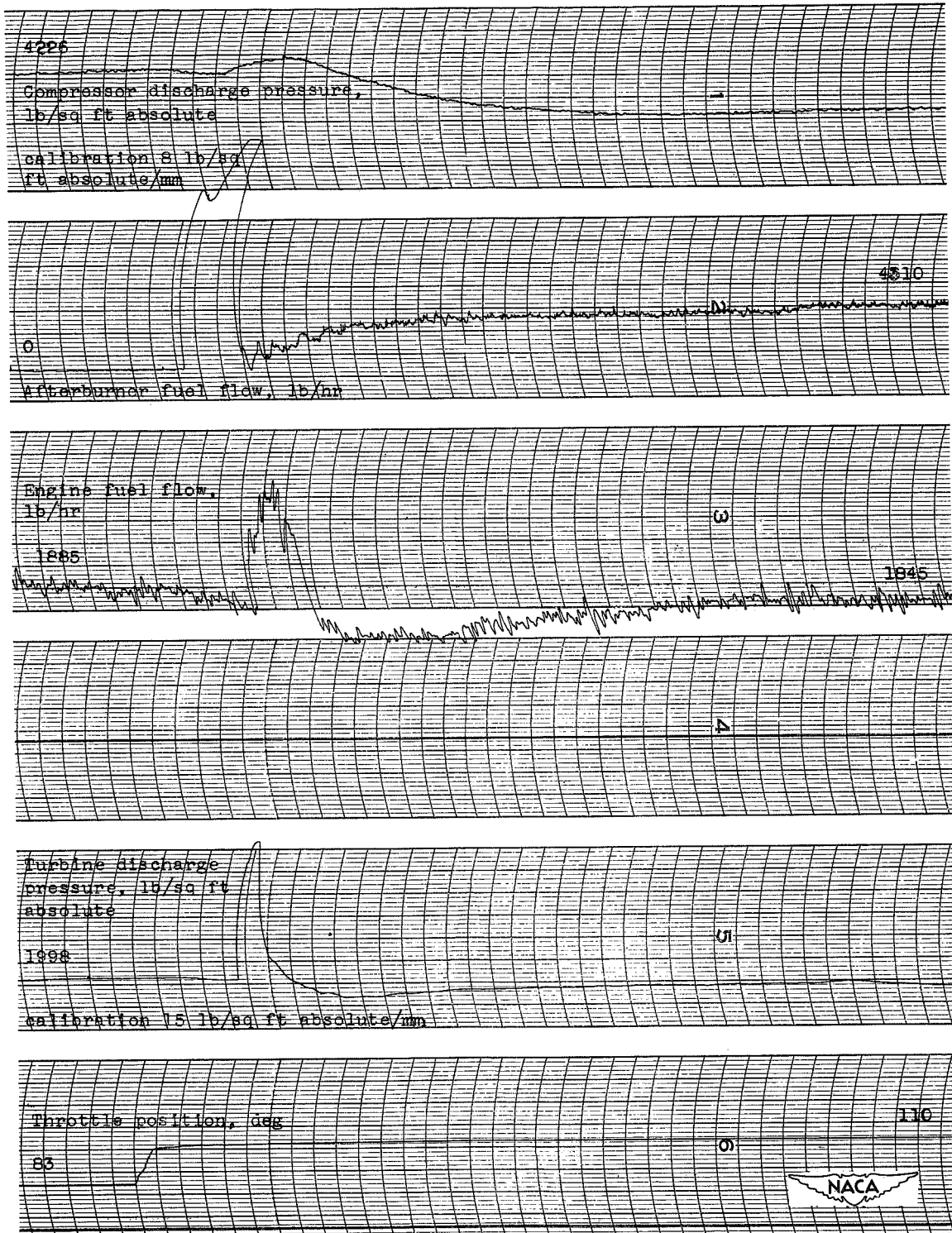


Figure 17. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 83° to 110°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

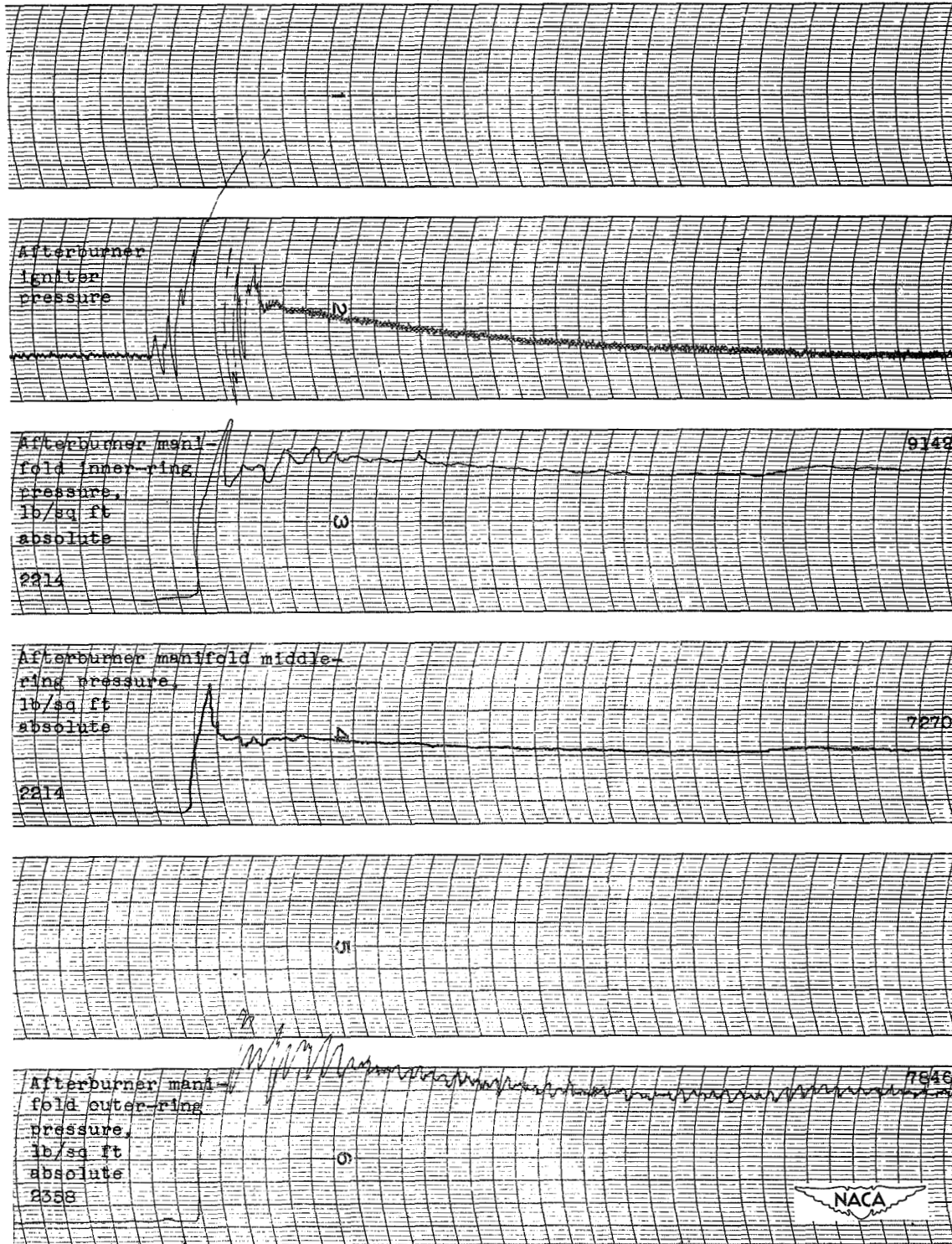


Figure 17. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 83° to 110°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

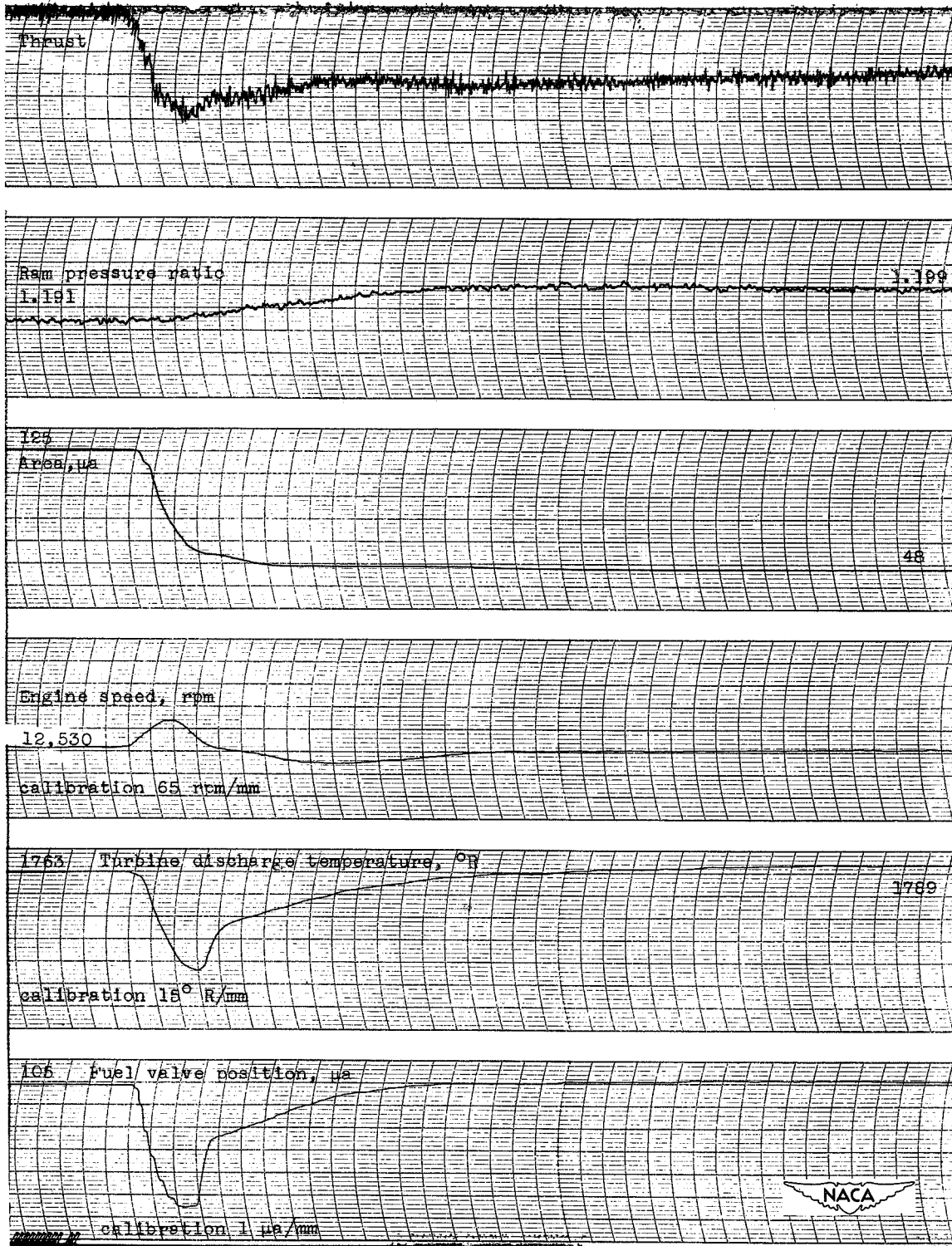


Figure 18. - Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 83°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

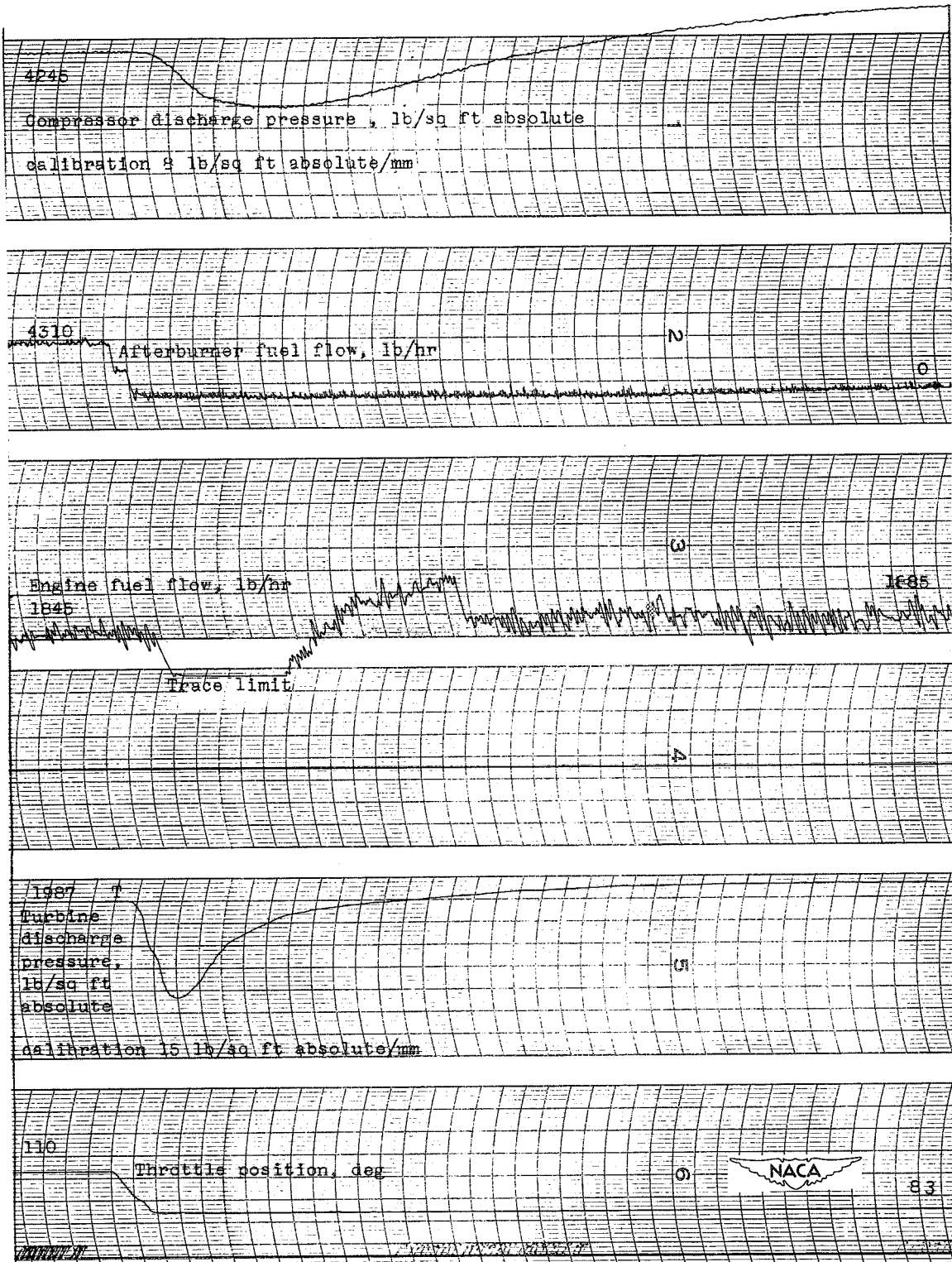


Figure 18. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 83°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

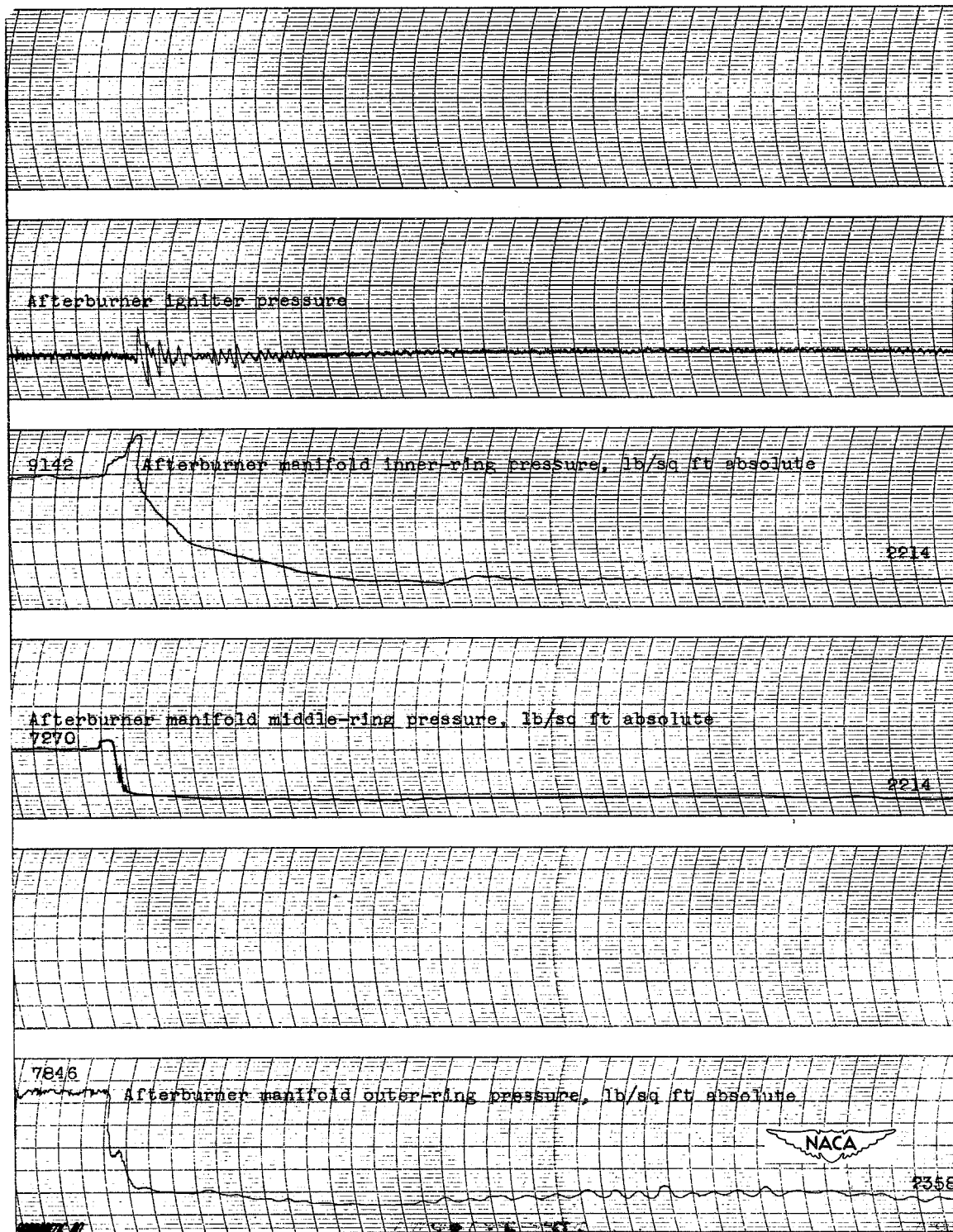


Figure 18. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 83° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

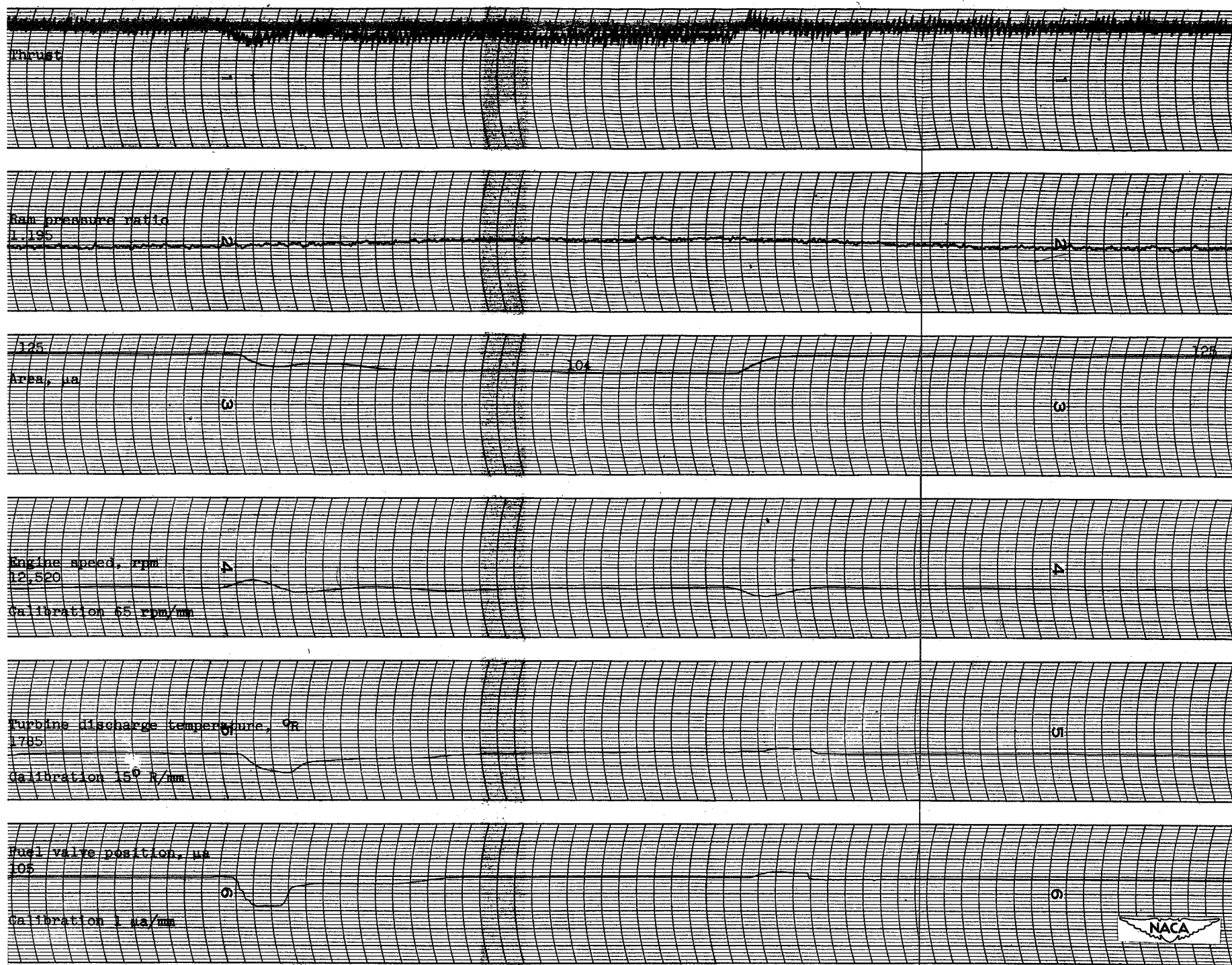


Figure 19. - Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 97° and 97° to 110° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

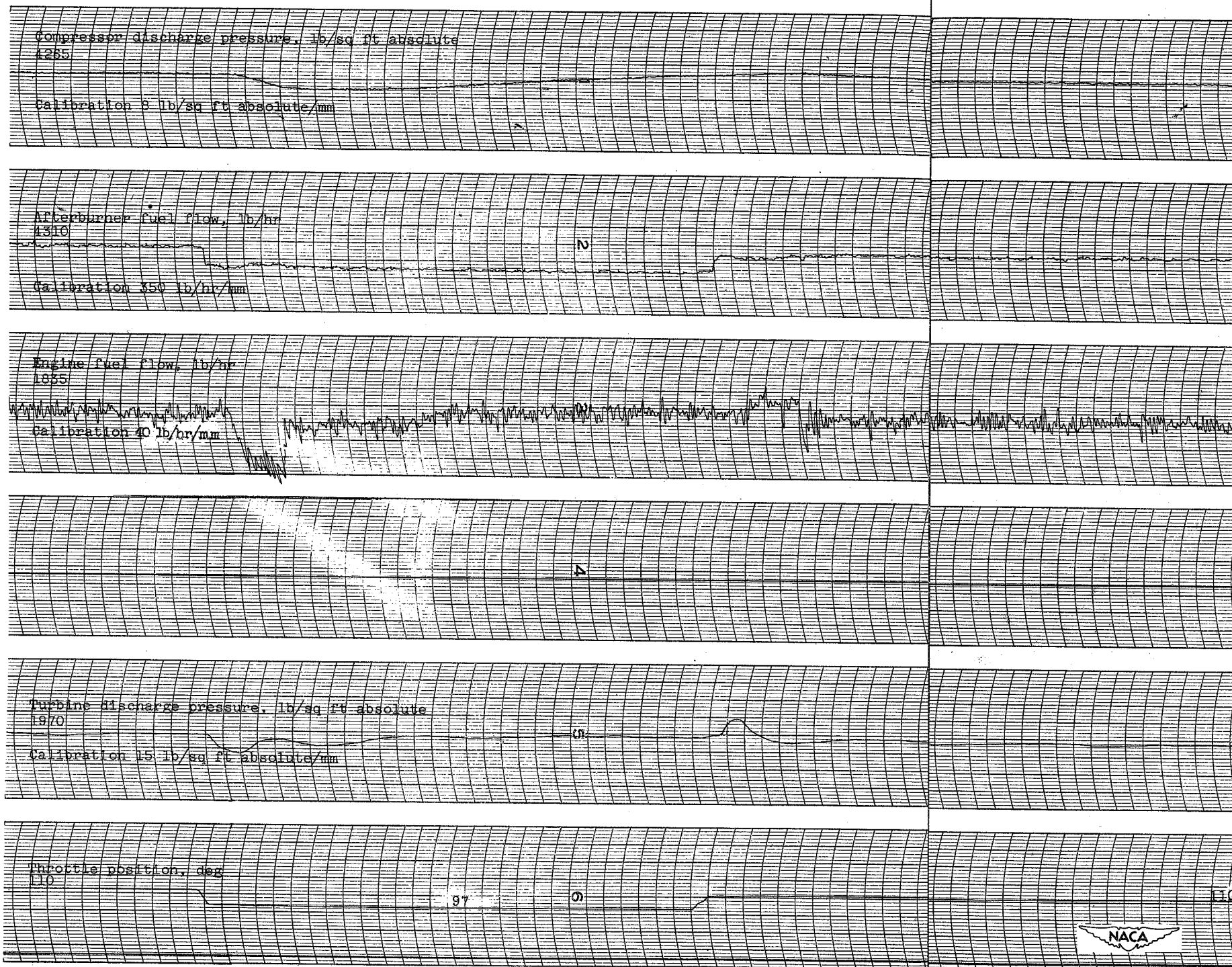


Figure 19. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 97° and 97° to 110° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

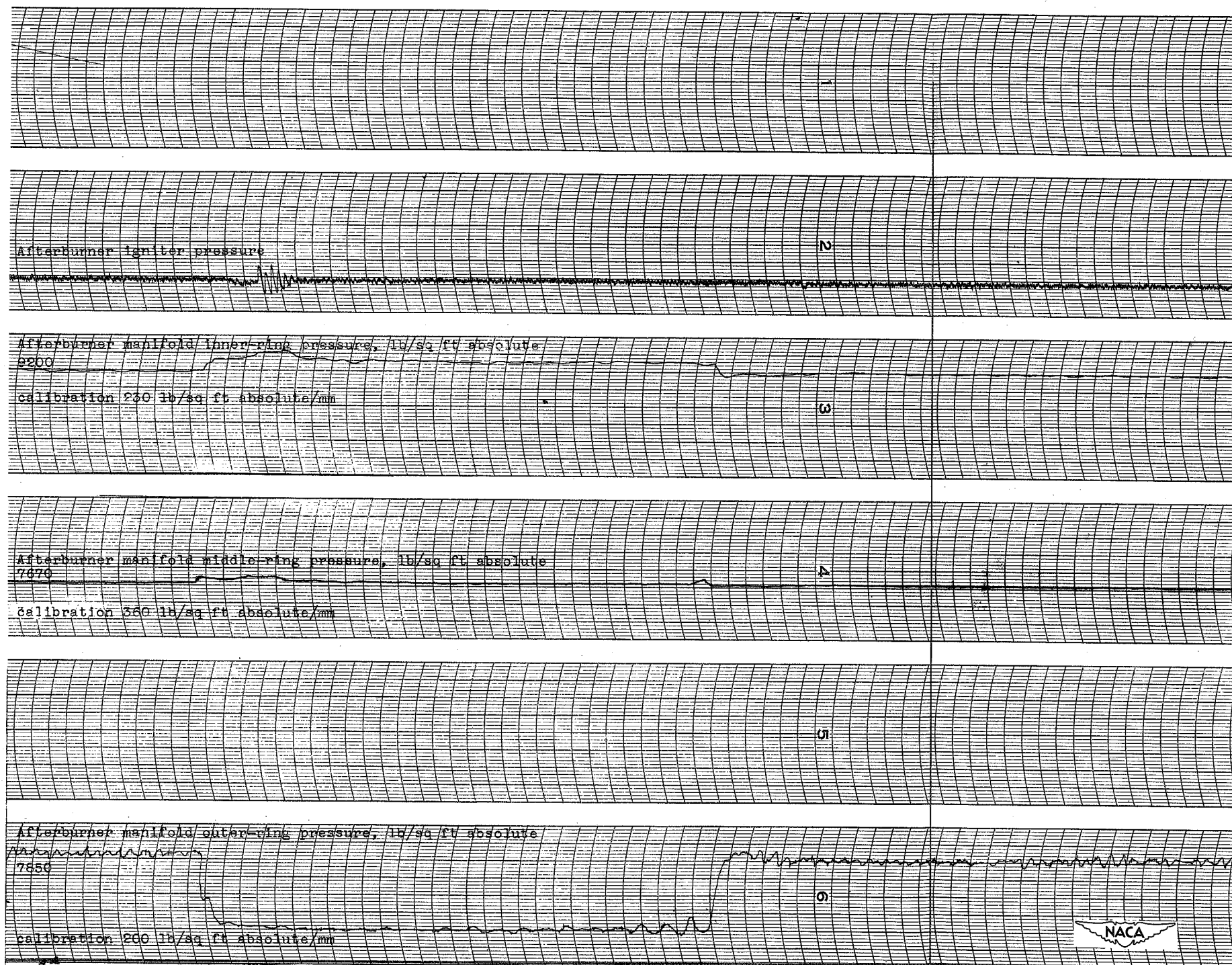


Figure 19. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 97° and 97° to 110° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

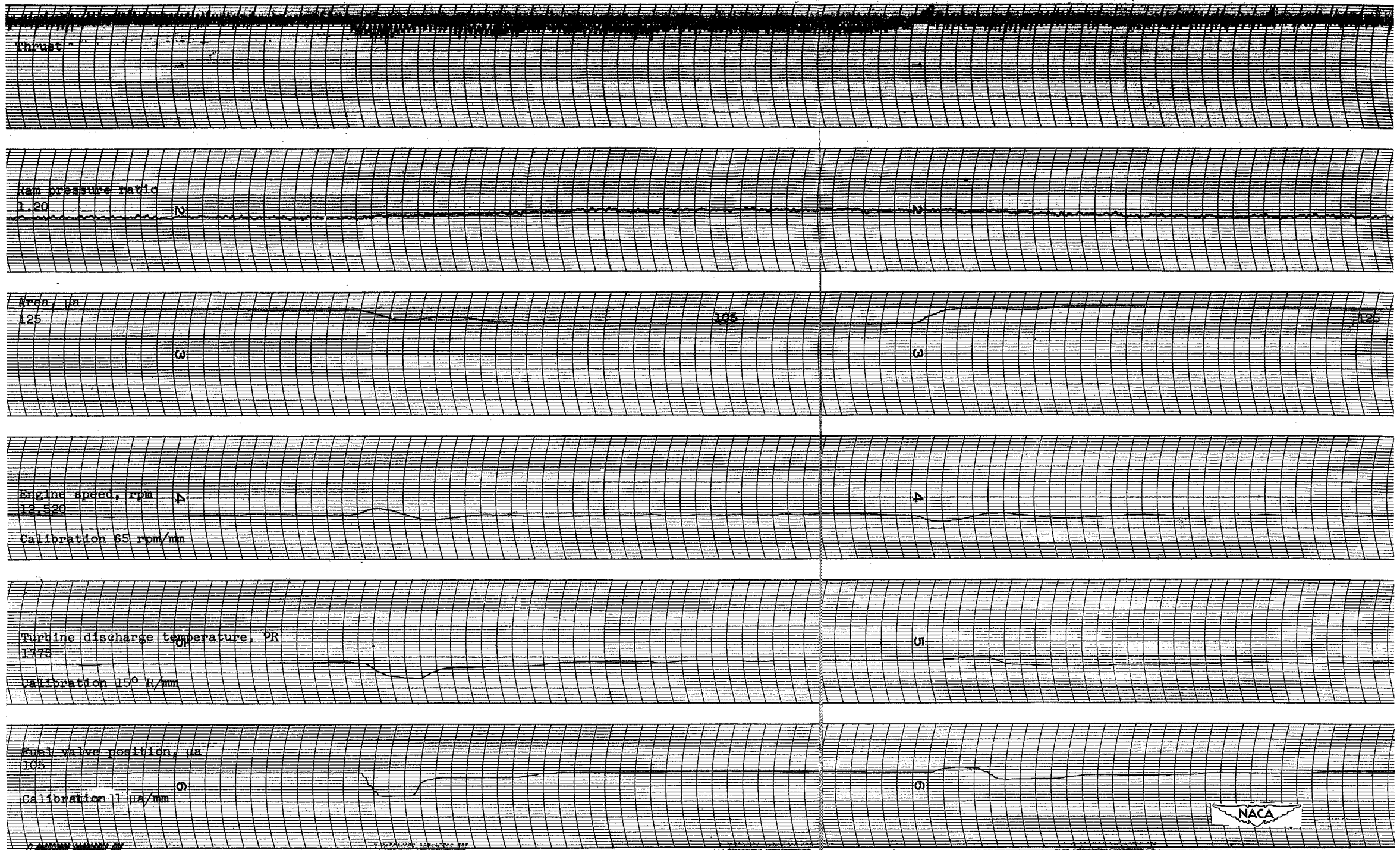


Figure 20. - Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 101° and 101° to 110°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

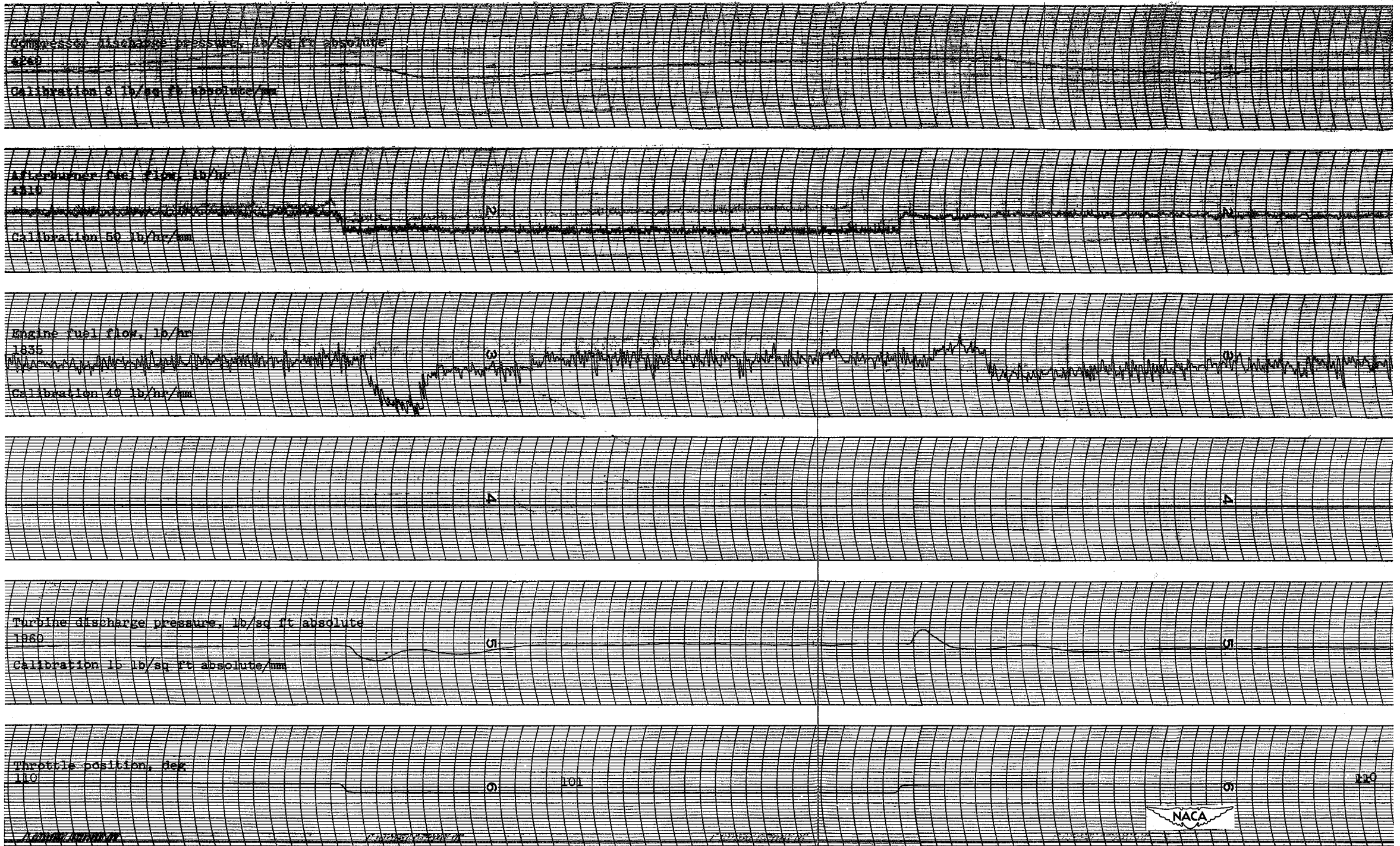


Figure 20. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 101° and 101° to 110°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

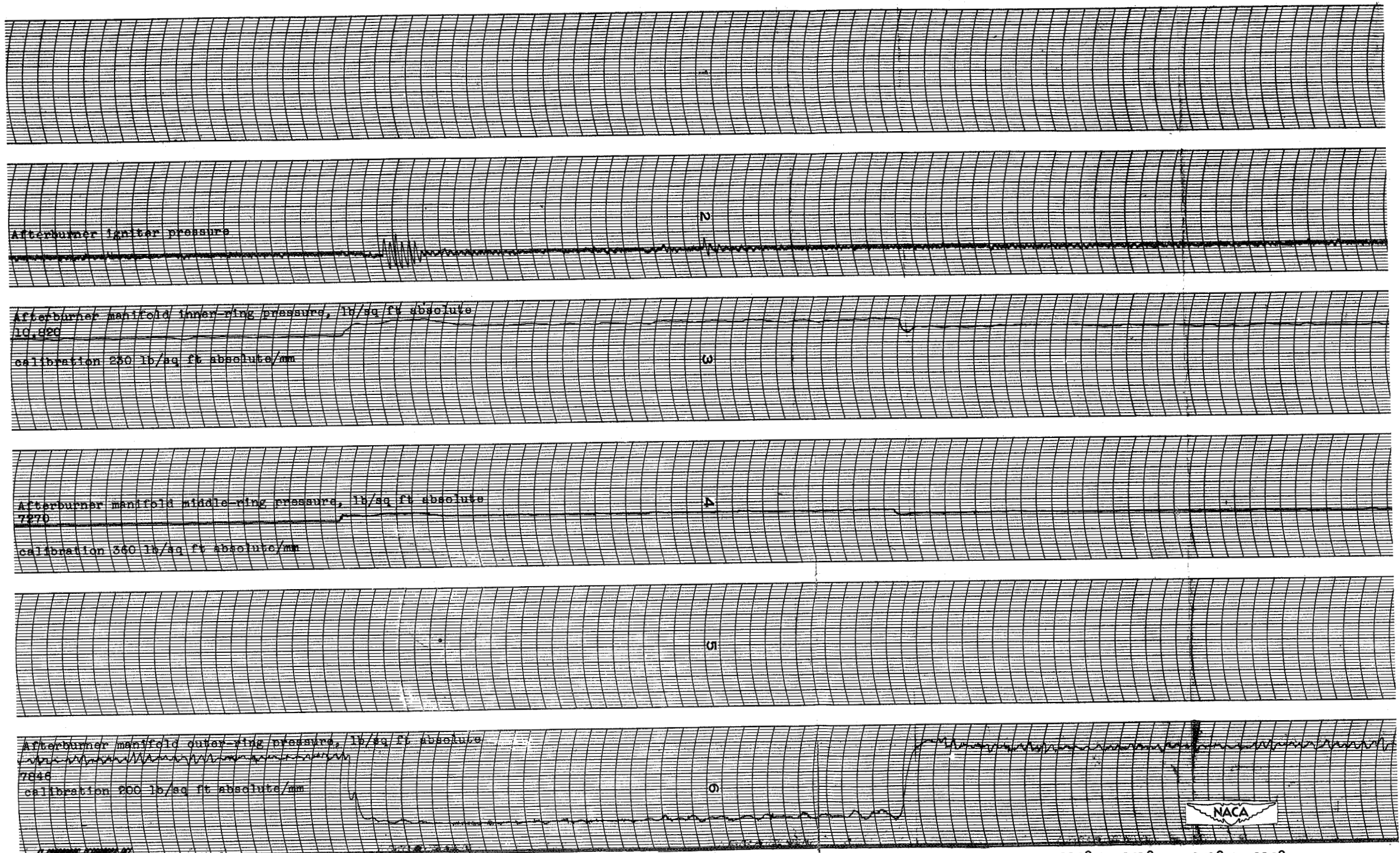


Figure 20. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 101° and 101° to 110°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

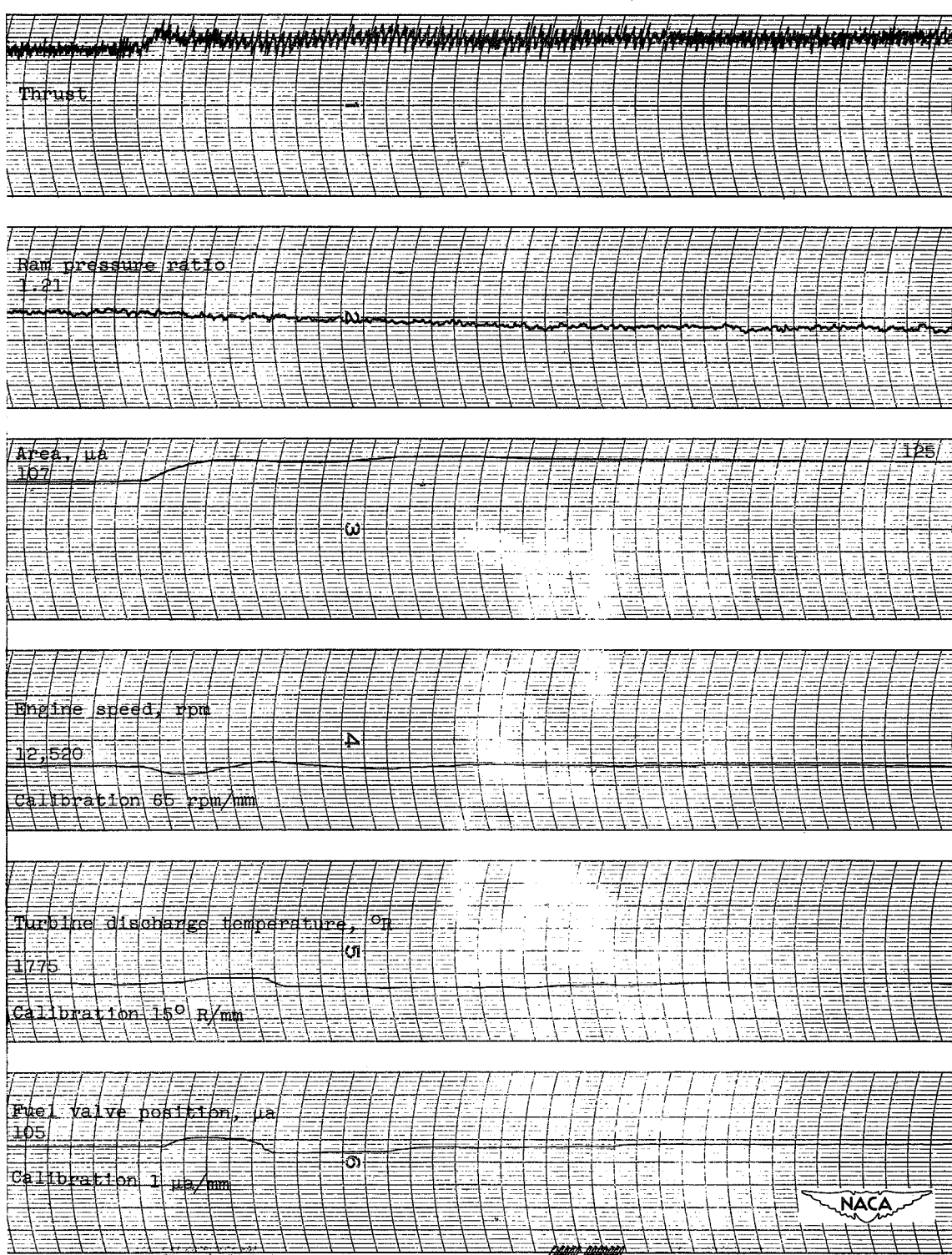


Figure 21. - Transient operation of automatically controlled engine with afterburner. Throttle position, 105° to 110°; altitude 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

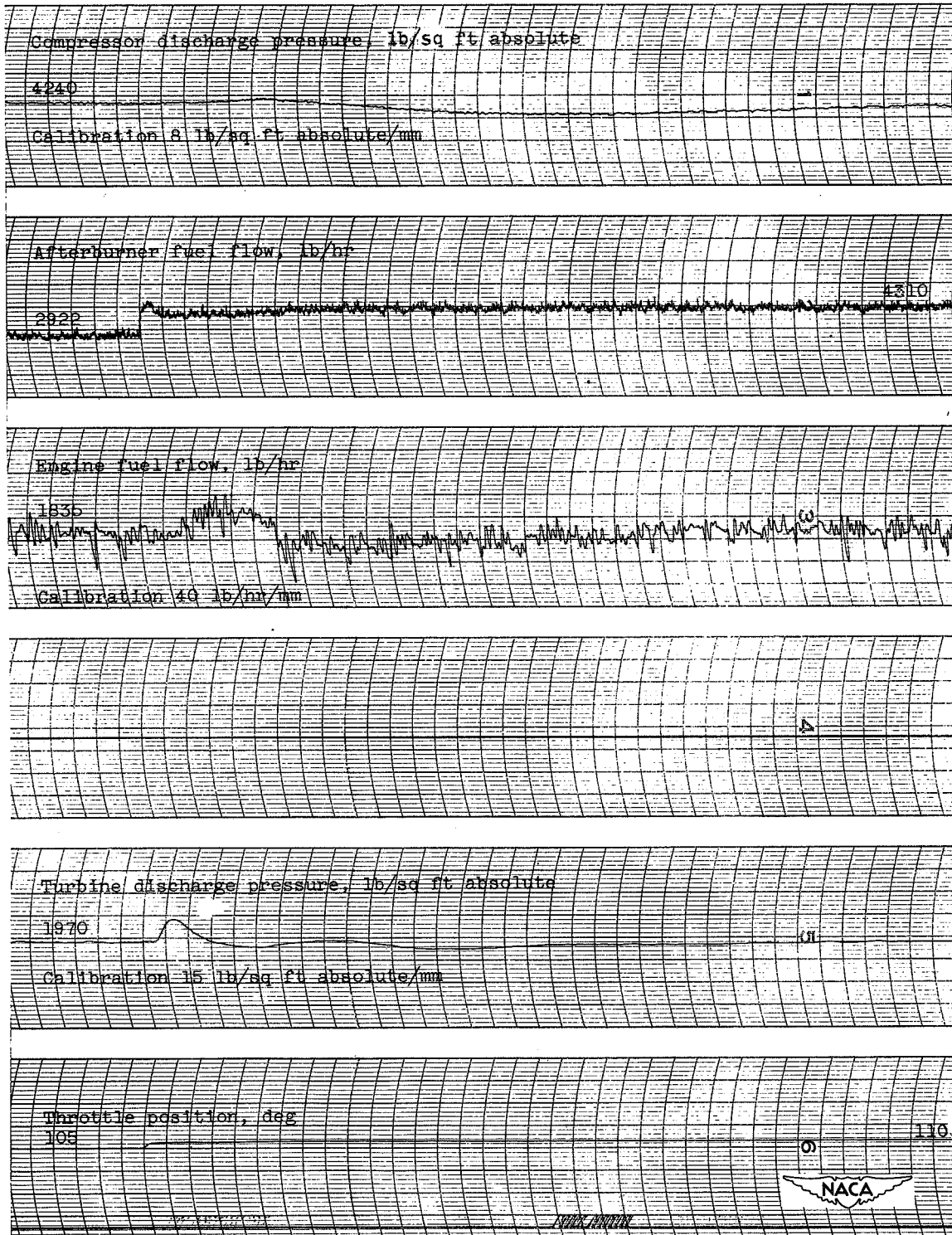


Figure 21. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 105° to 110°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

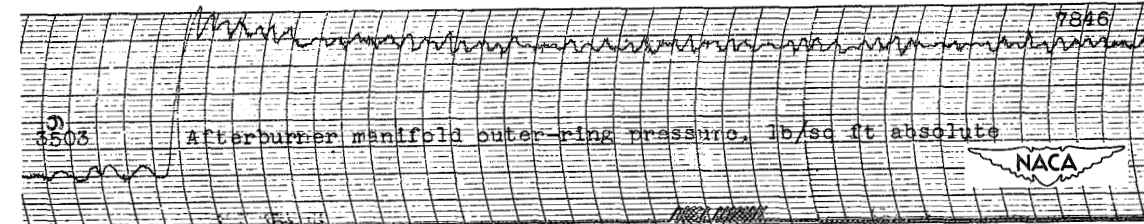
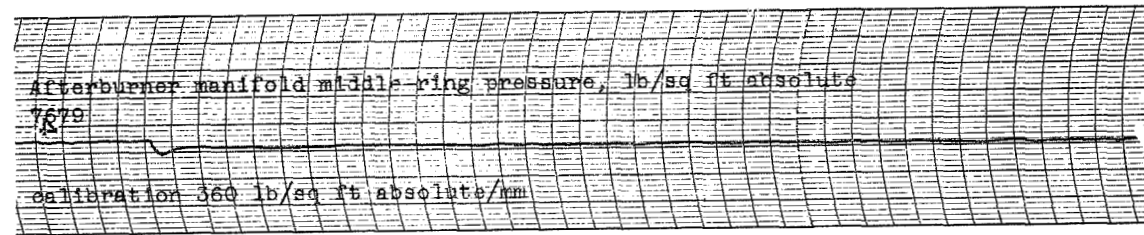
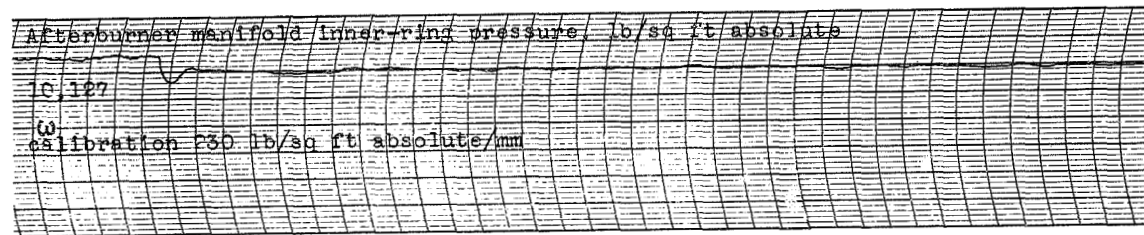
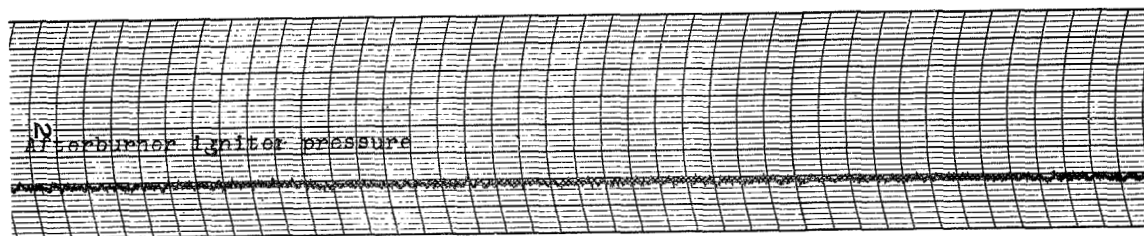
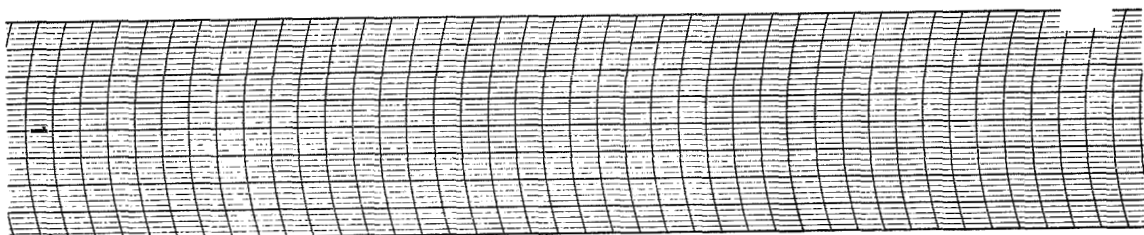


Figure 21. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 105° to 110°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

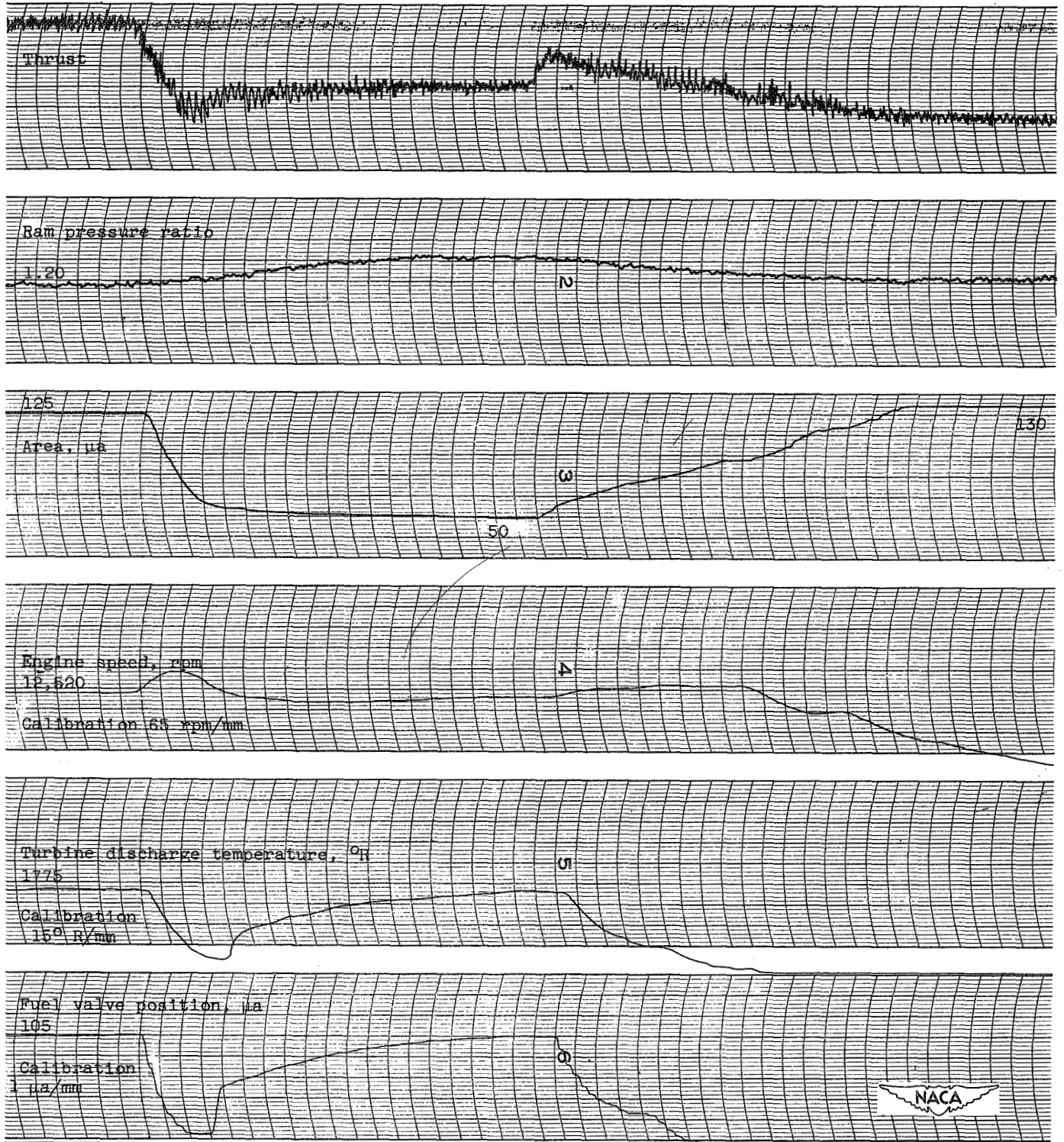


Figure 22. - Transient operation of automatically controlled engine with afterburner. Throttle position, 110 $^{\circ}$ to 93 $^{\circ}$ and cut off; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

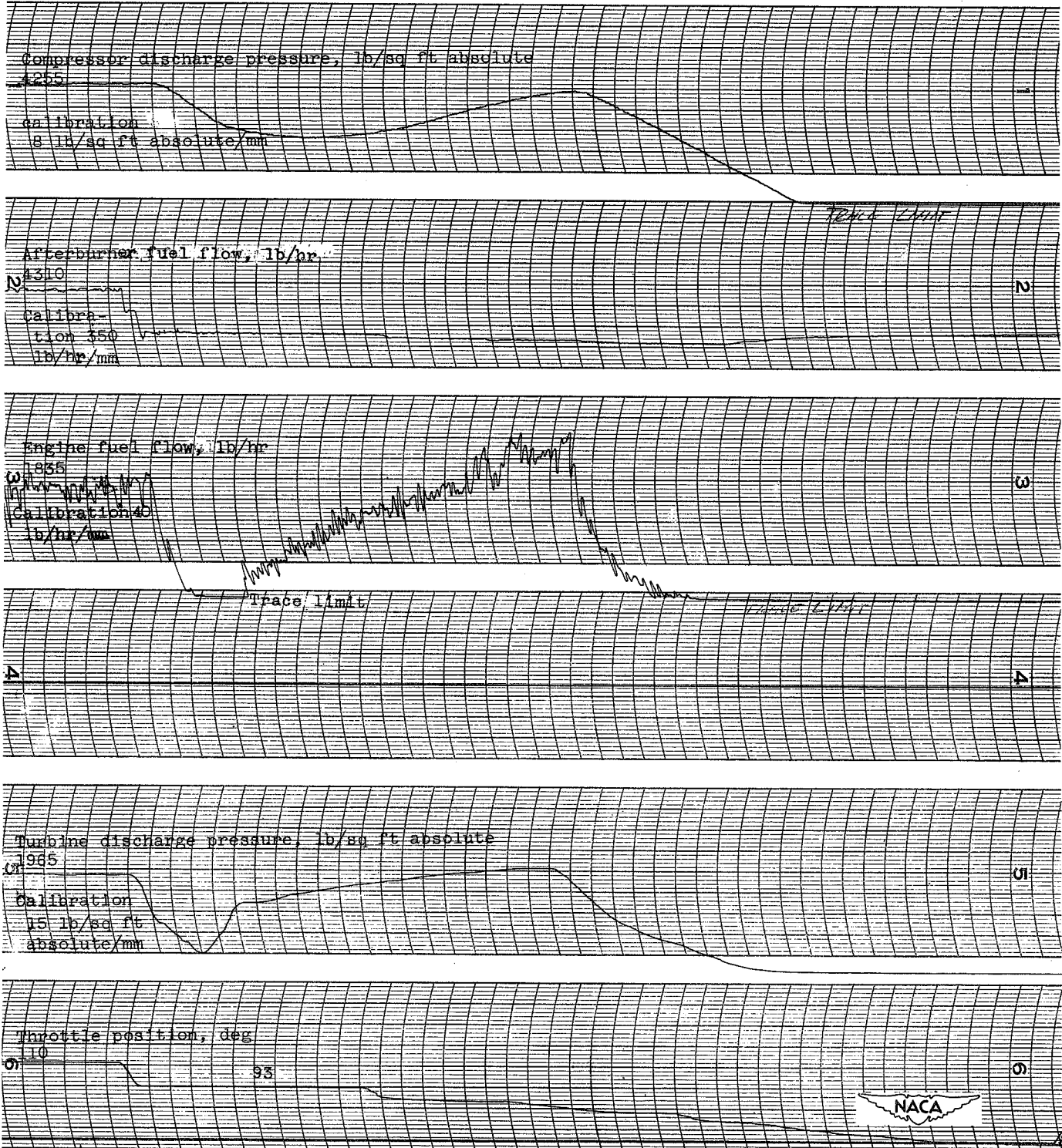


Figure 22. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 93° and cut off; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

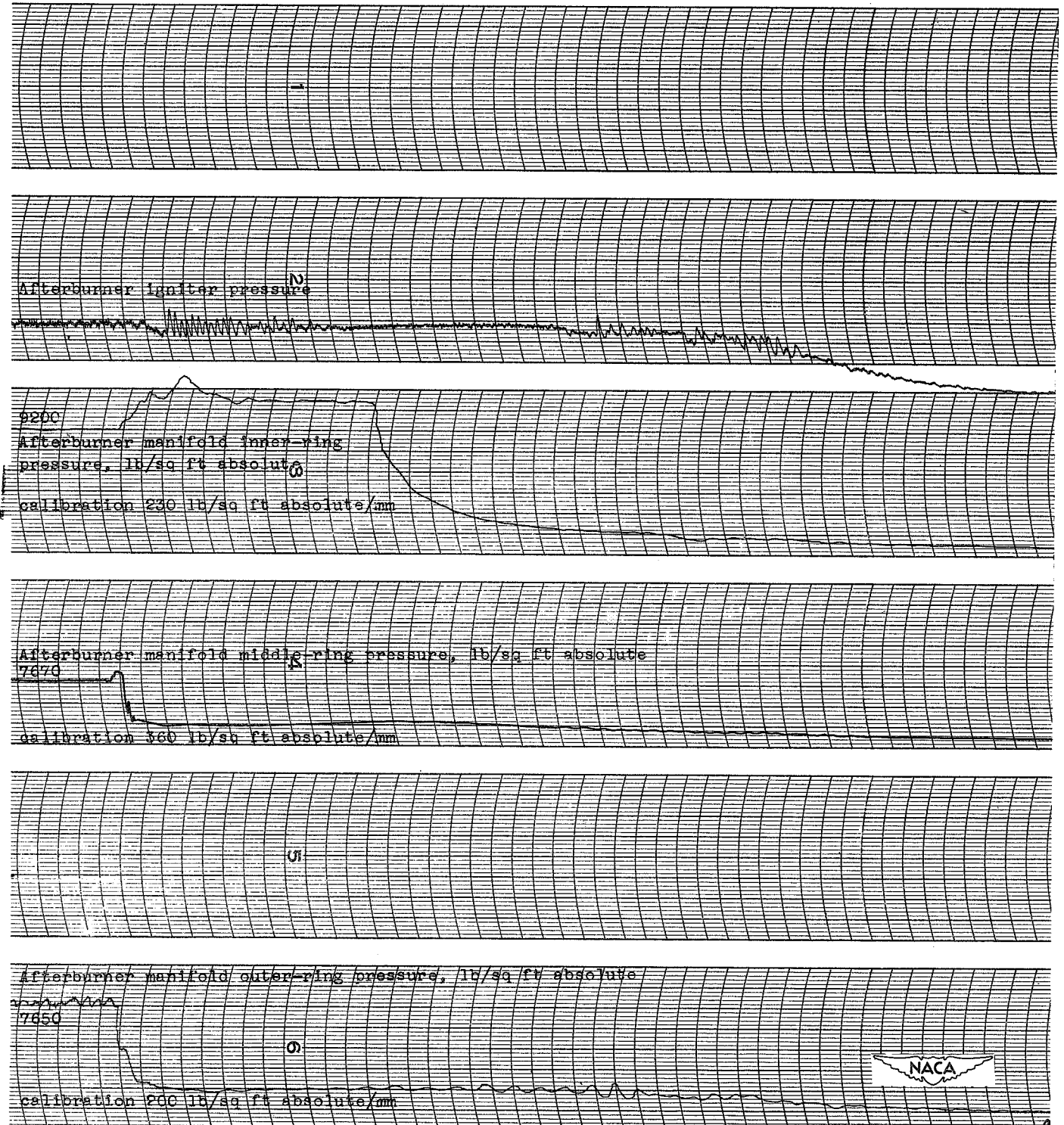


Figure 22. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 93° and cut off; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 26 pounds per square inch.

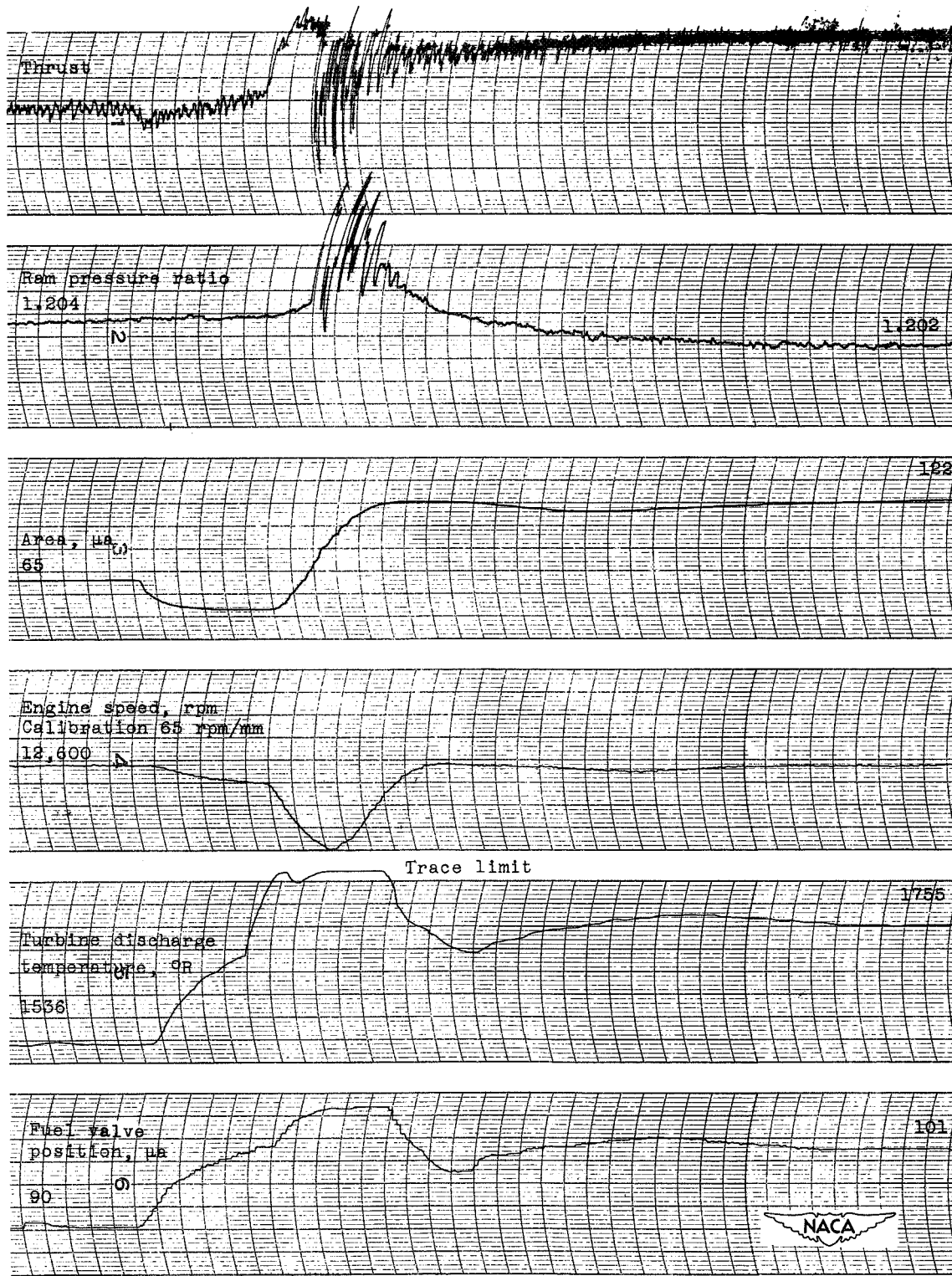


Figure 23. - Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 108° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

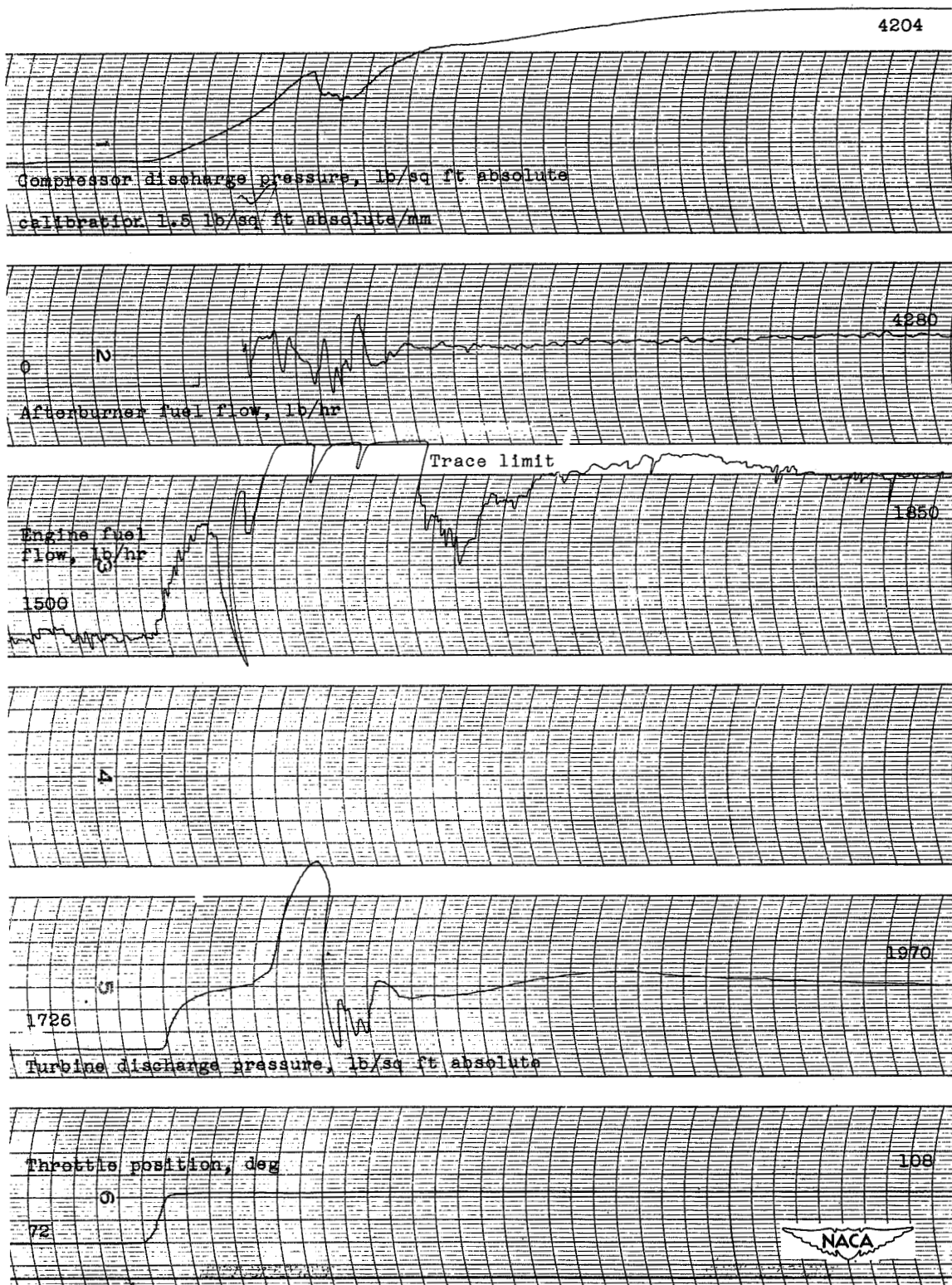


Figure 23. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 108°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

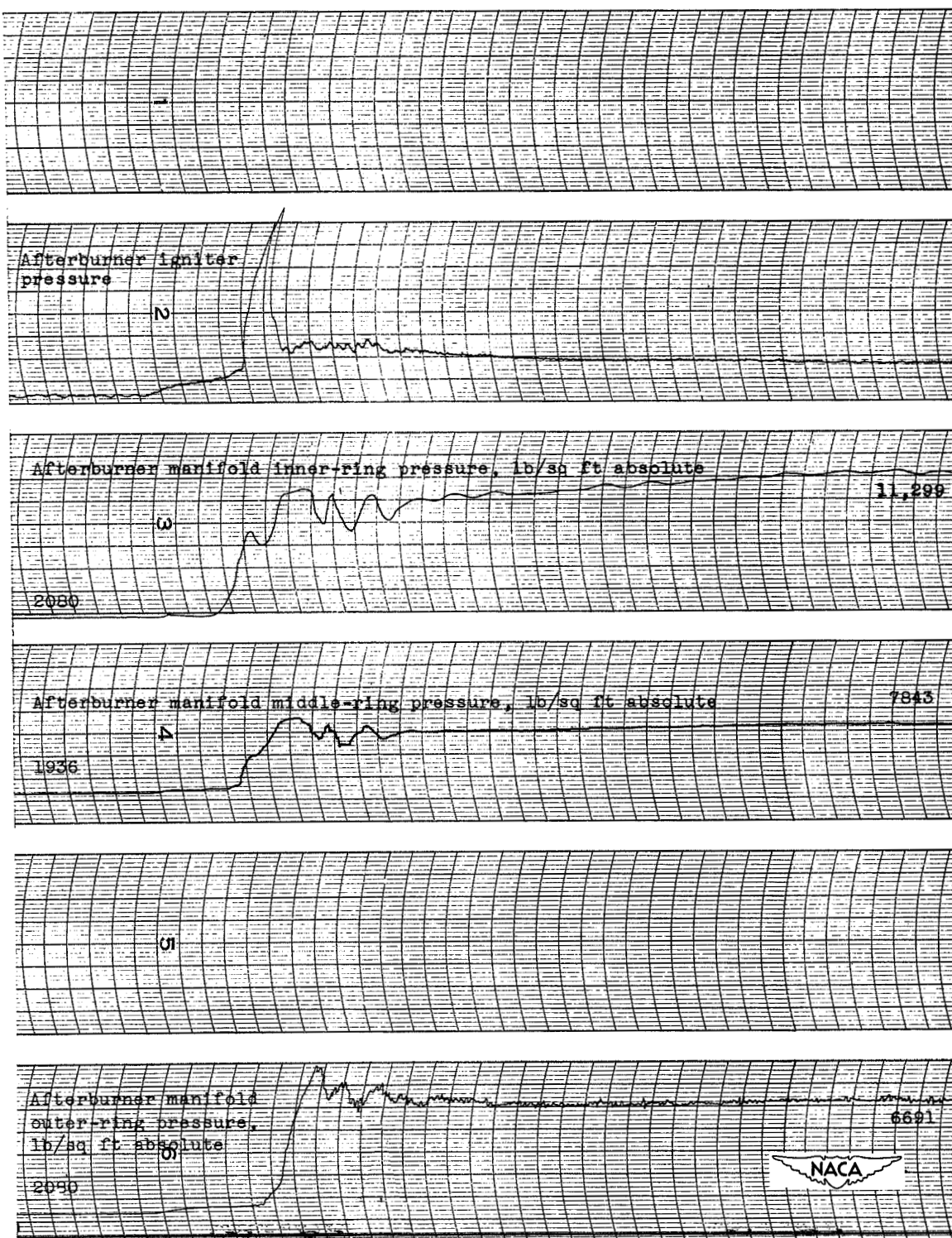


Figure 23. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 108°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

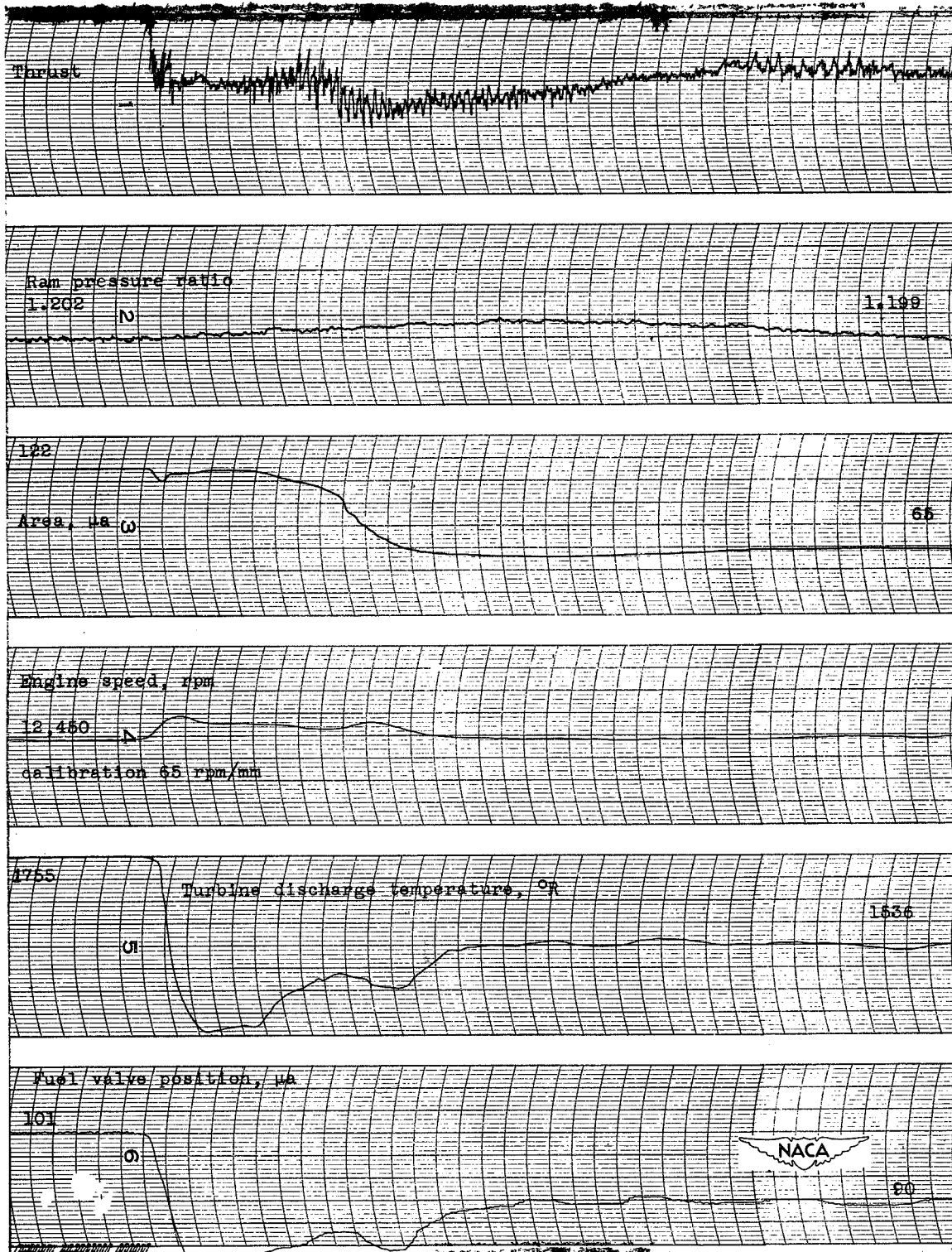


Figure 24. - Transient operation of automatically controlled engine with after-burner. Throttle position, 108° to 72°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

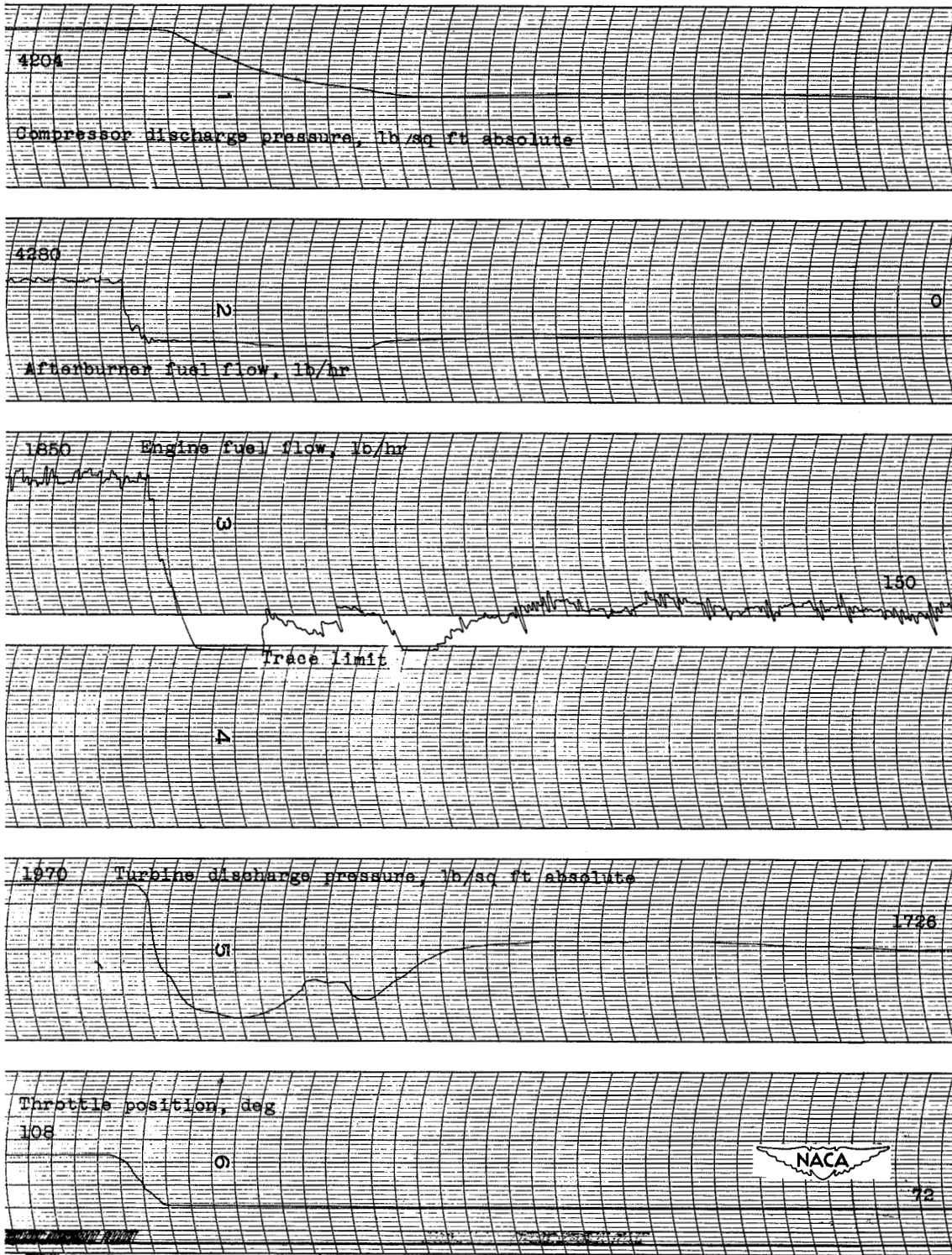


Figure 24. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 72°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

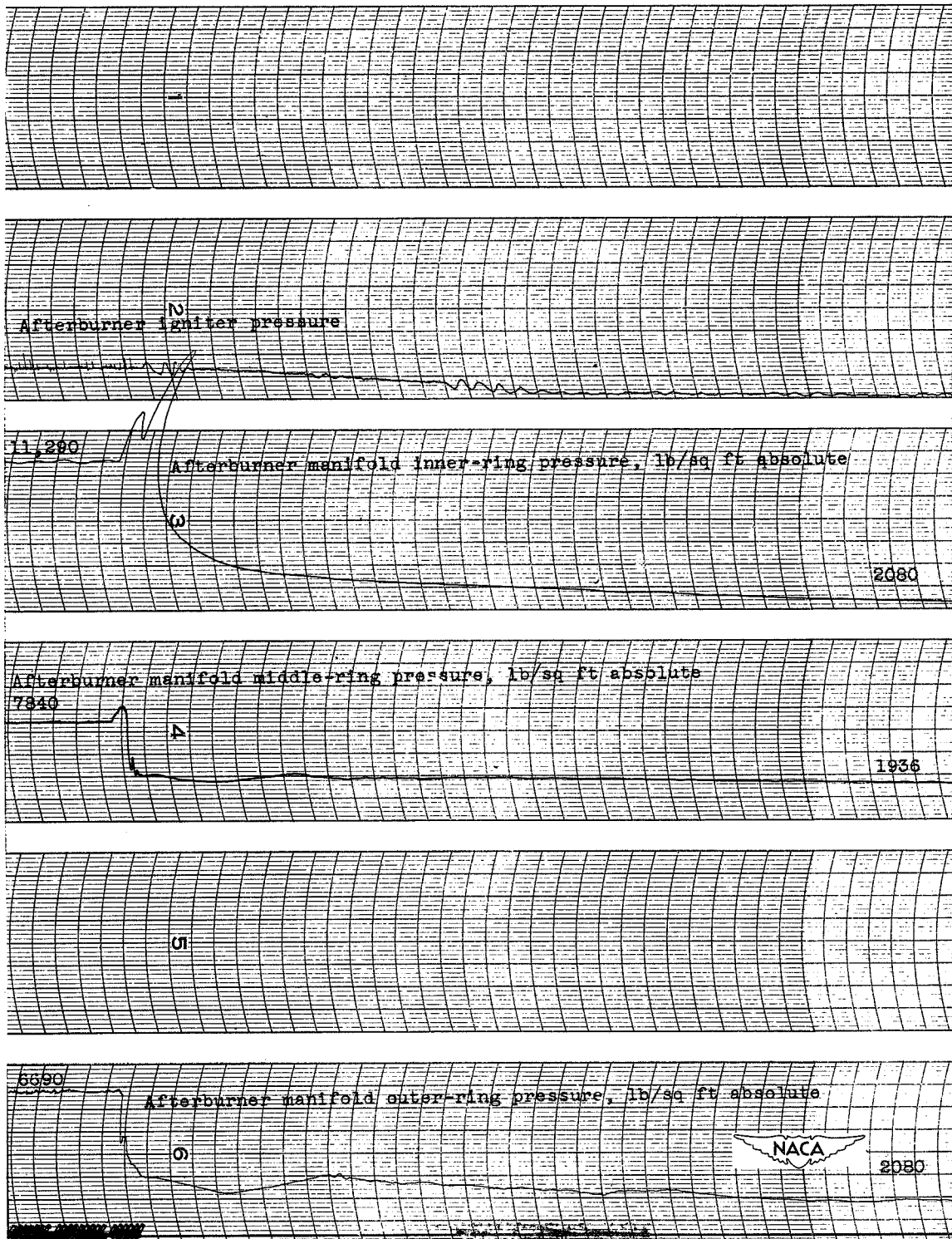


Figure 24. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 72°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

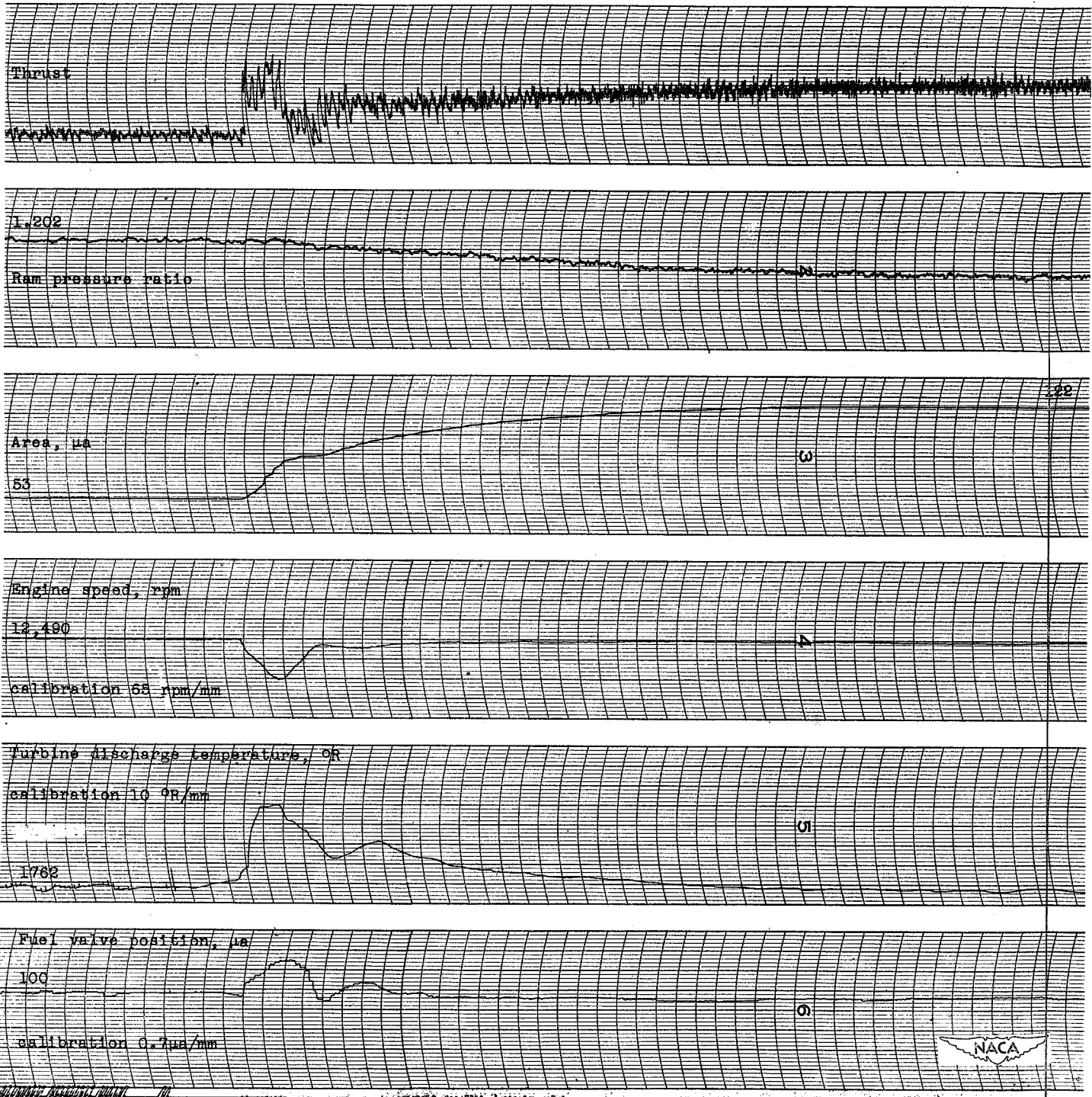


Figure 25. - Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 108° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

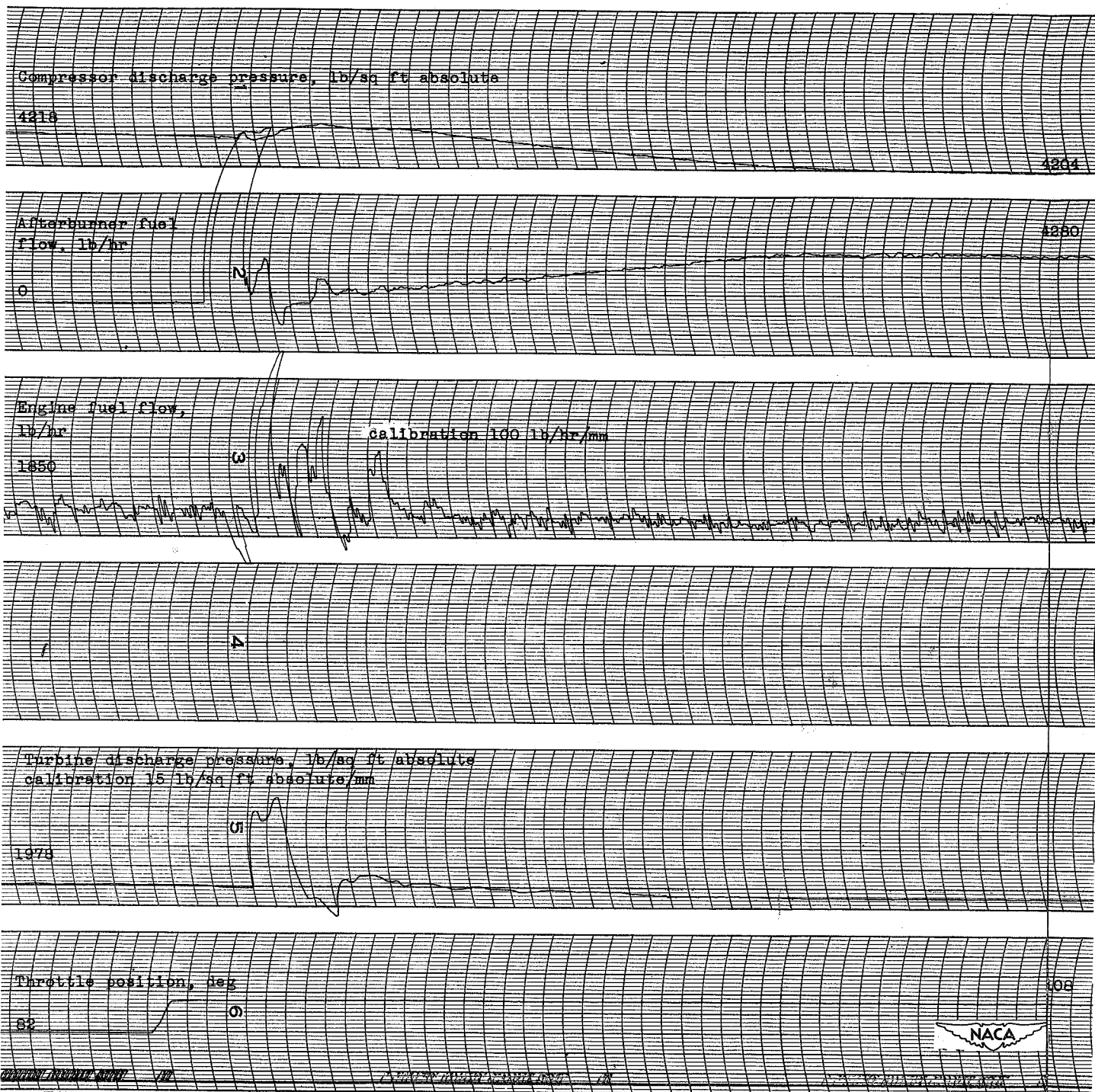


Figure 25. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 108° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

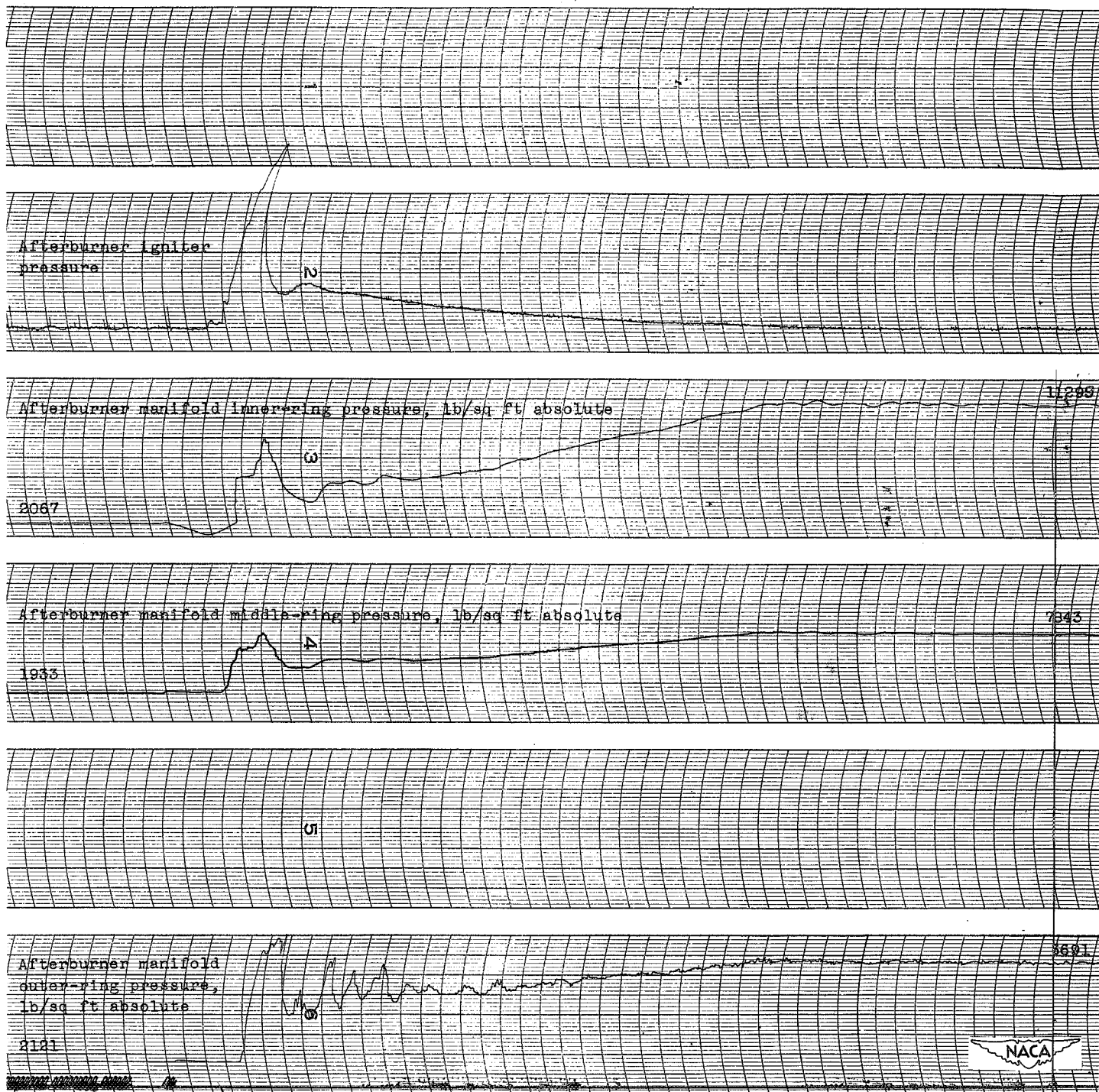


Figure 25. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 108° ; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

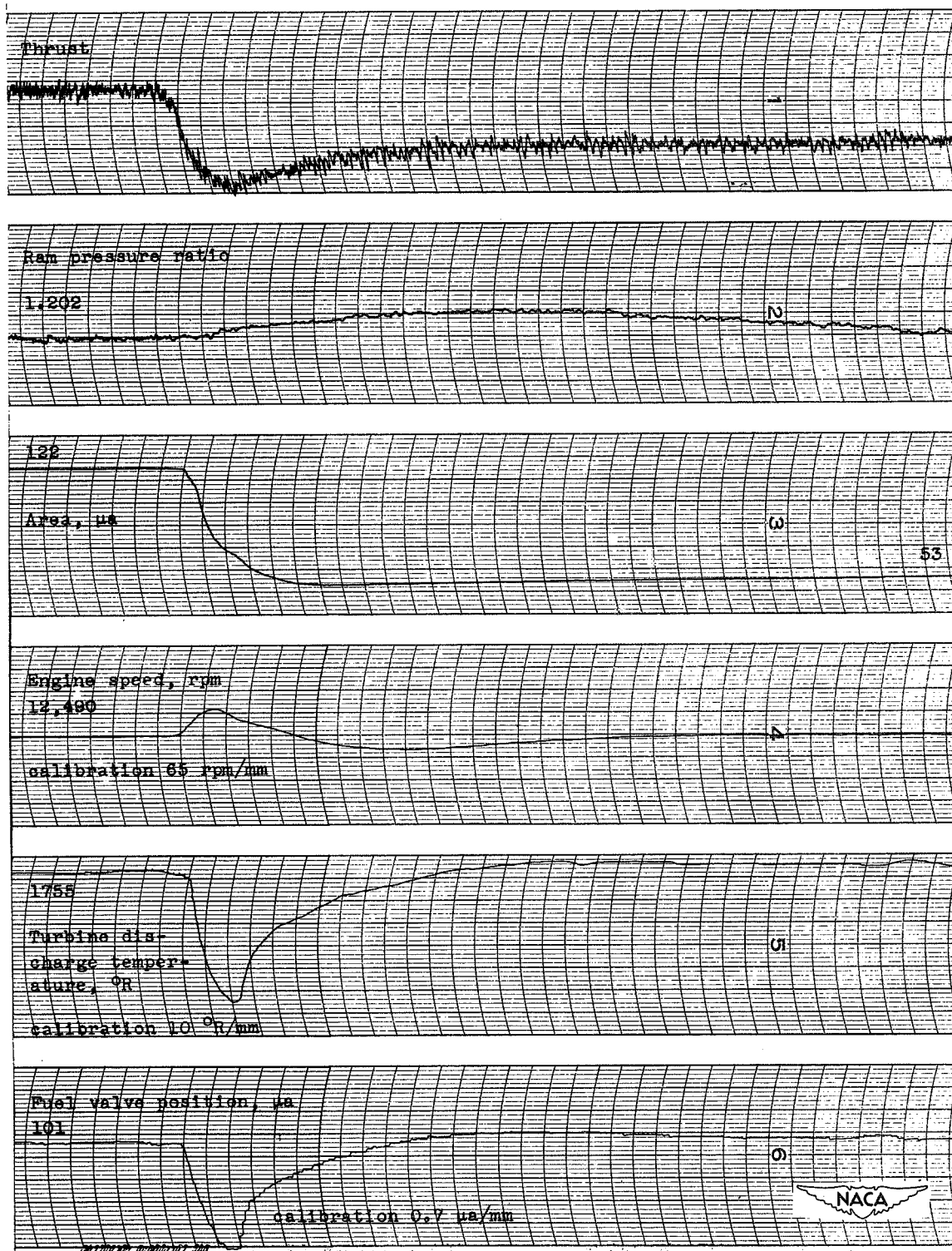


Figure 26. - Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 82°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

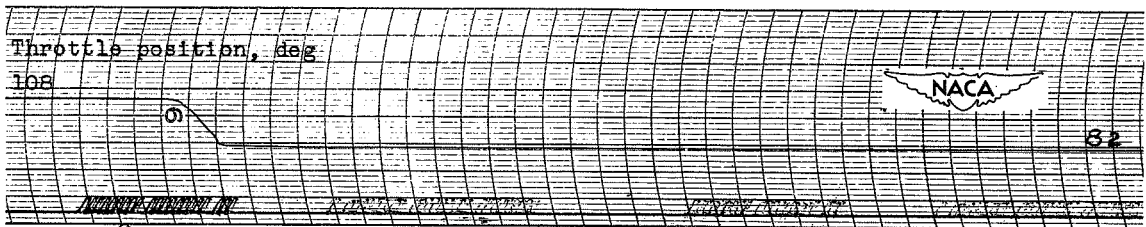
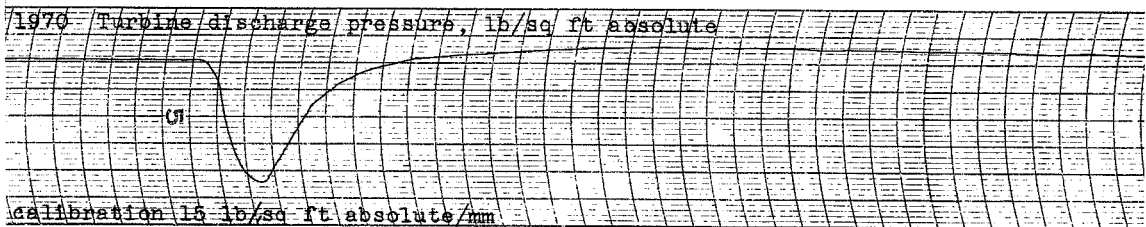
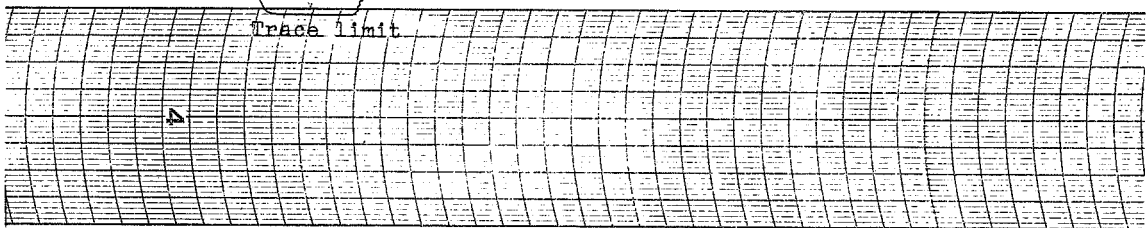
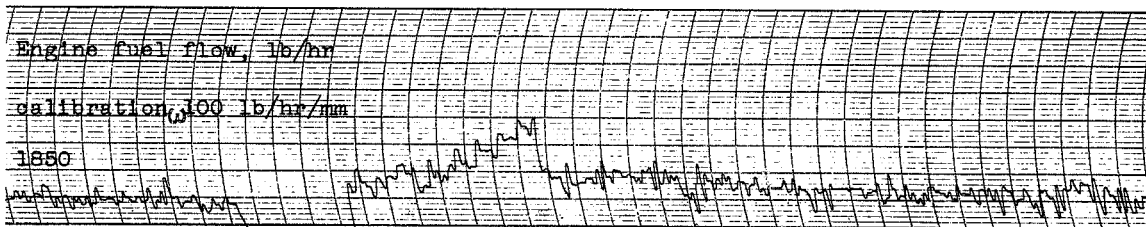
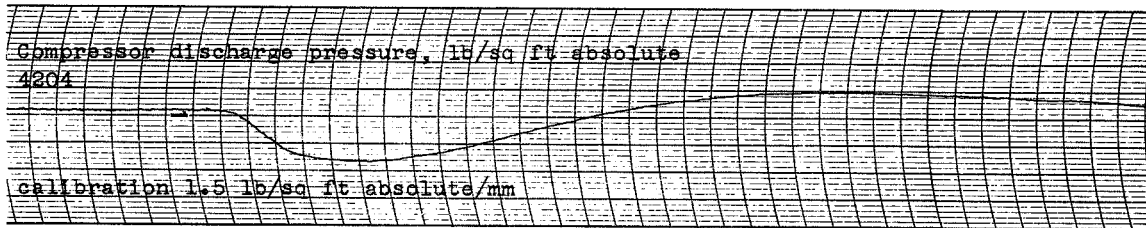


Figure 26. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 82°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

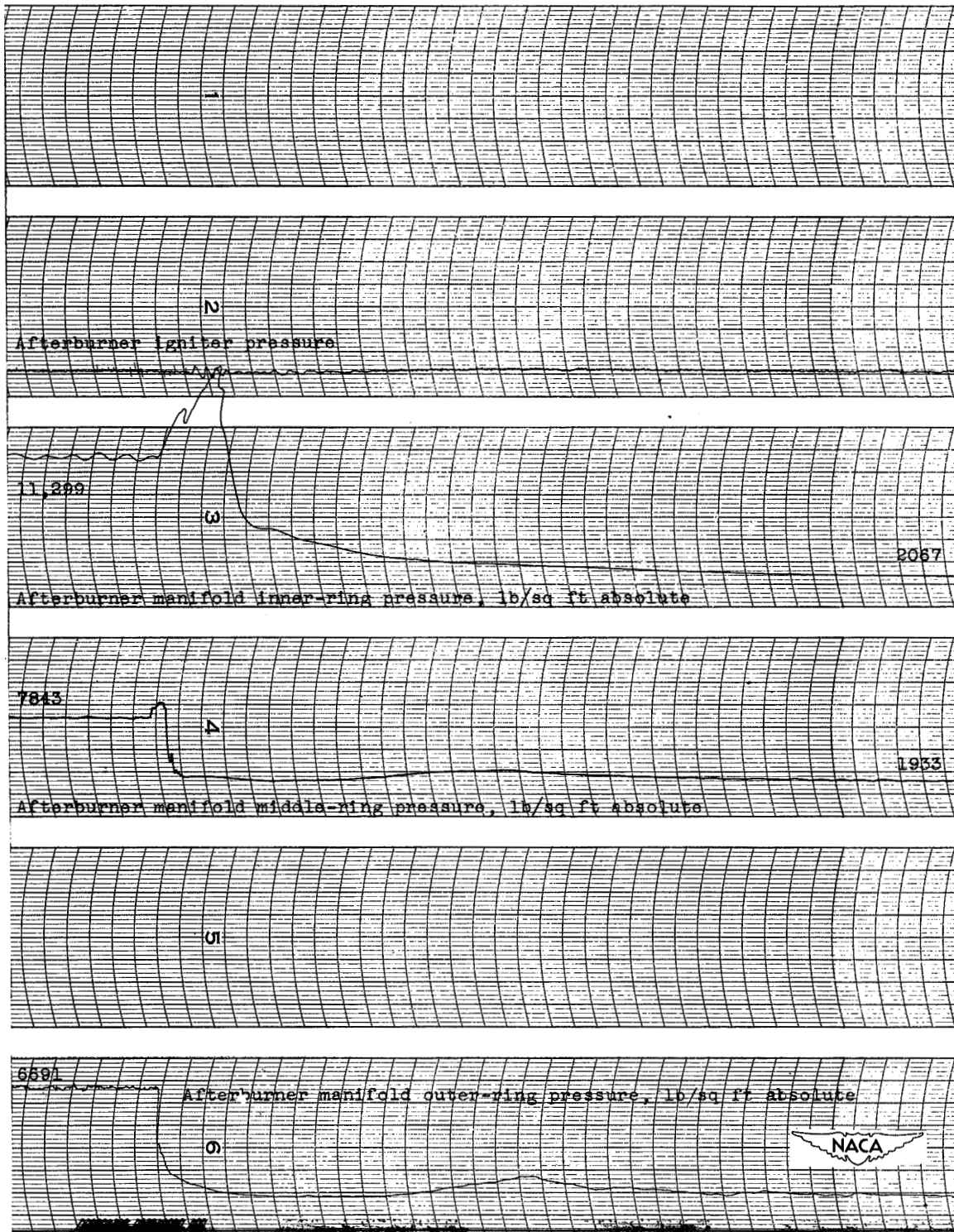


Figure 26. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 82°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

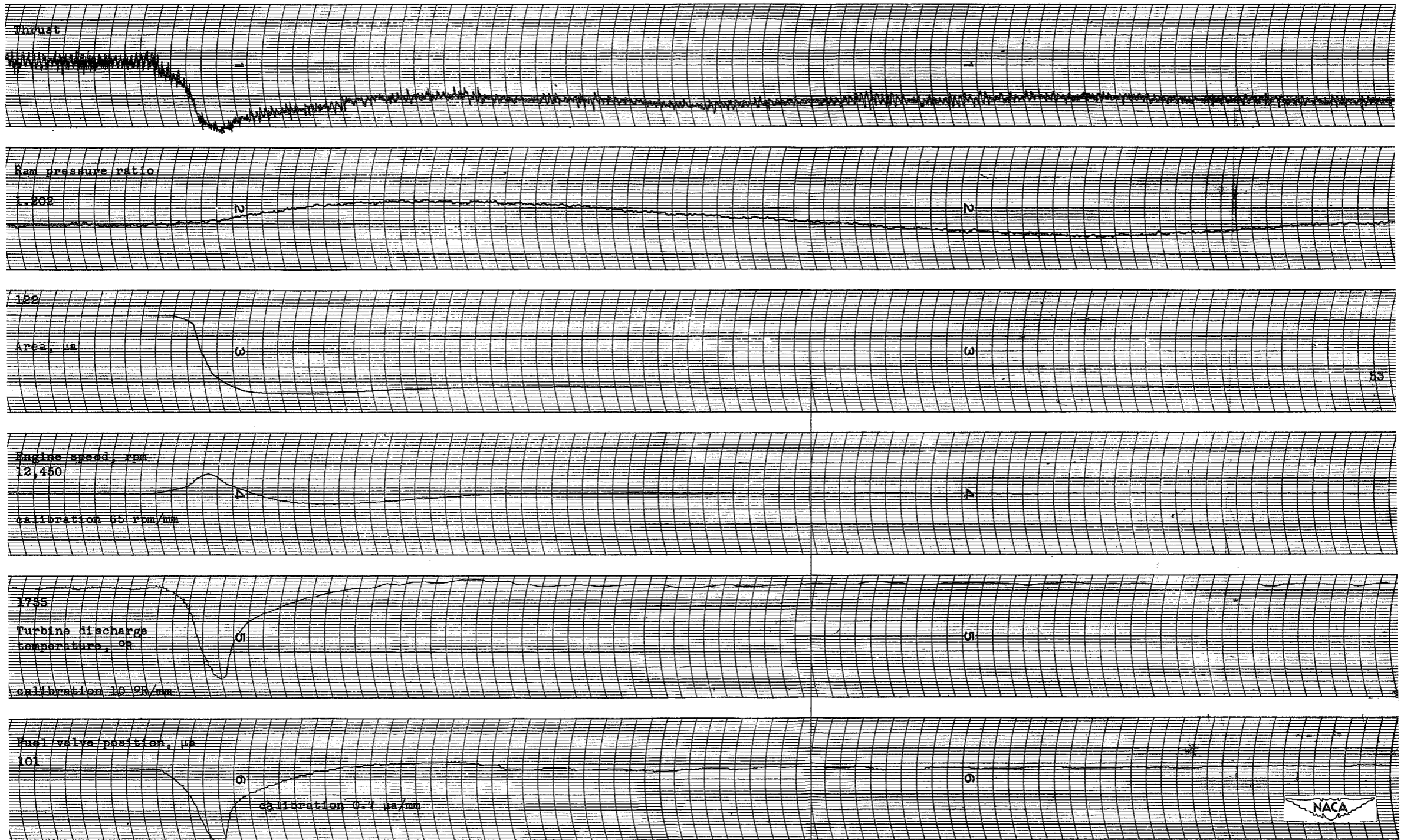


Figure 27. - Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 90° and 90° to 82°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

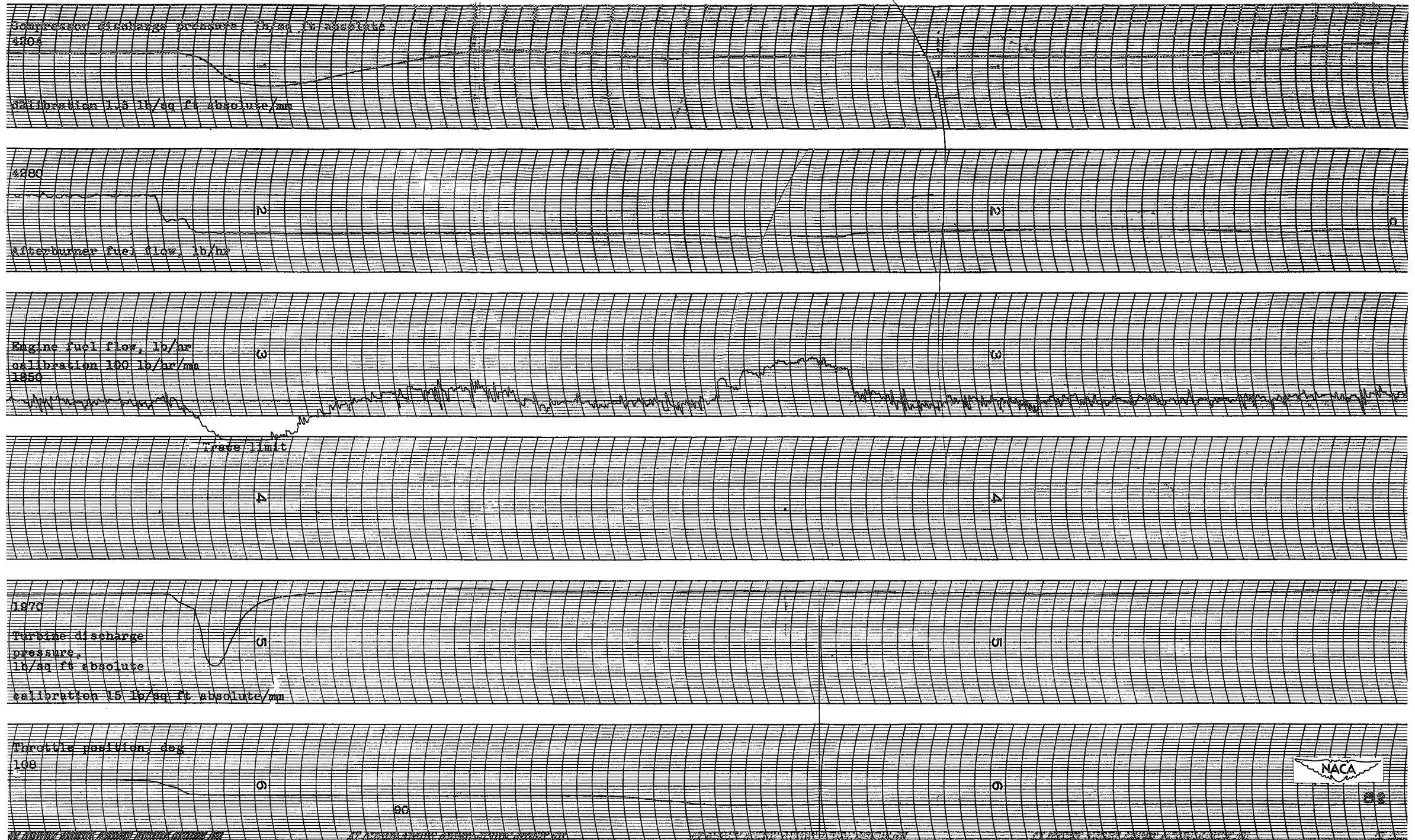


Figure 27. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 90° and 90° to 82°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

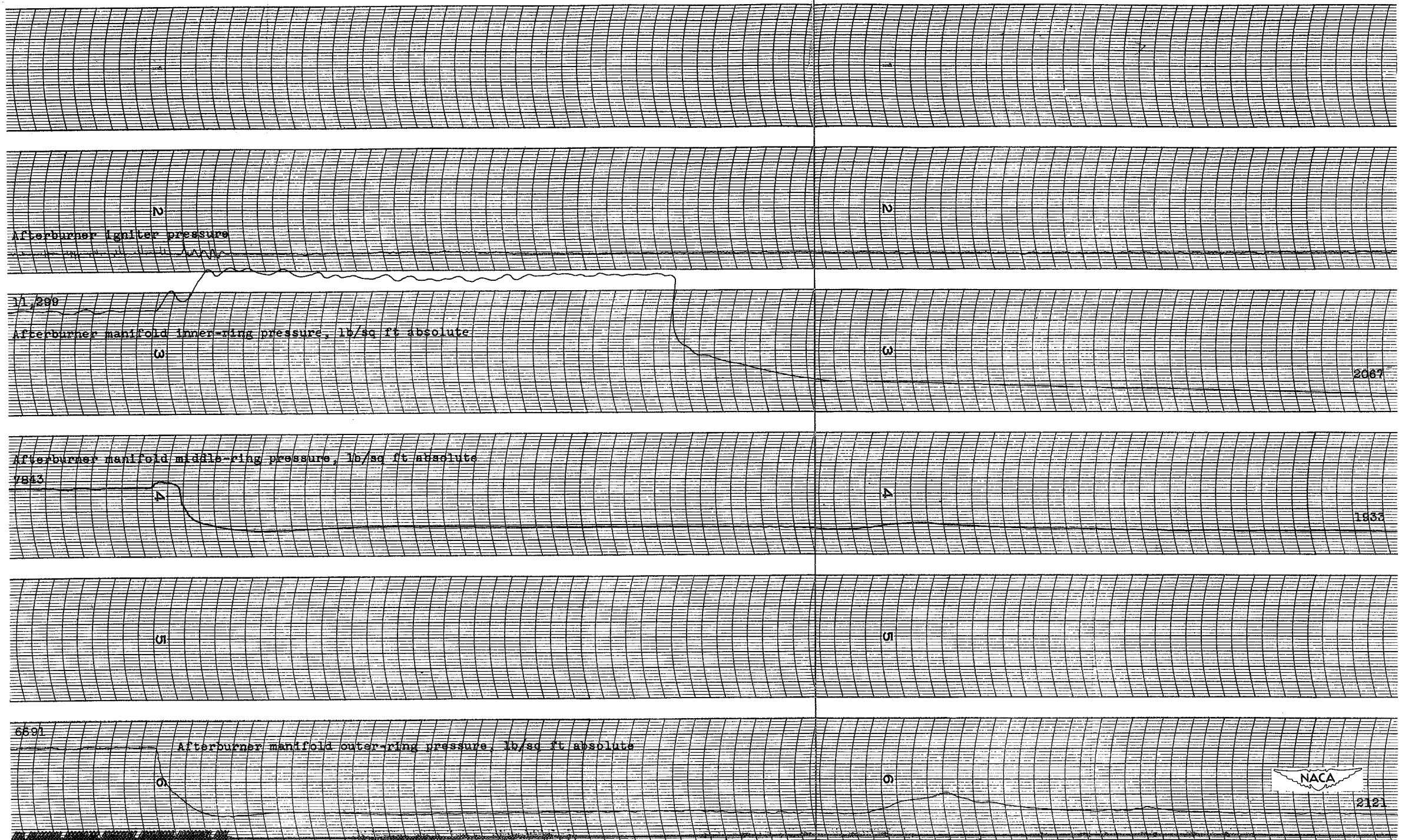


Figure 27. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 90° and 90° to 82°; altitude, 25,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 30 pounds per square inch.

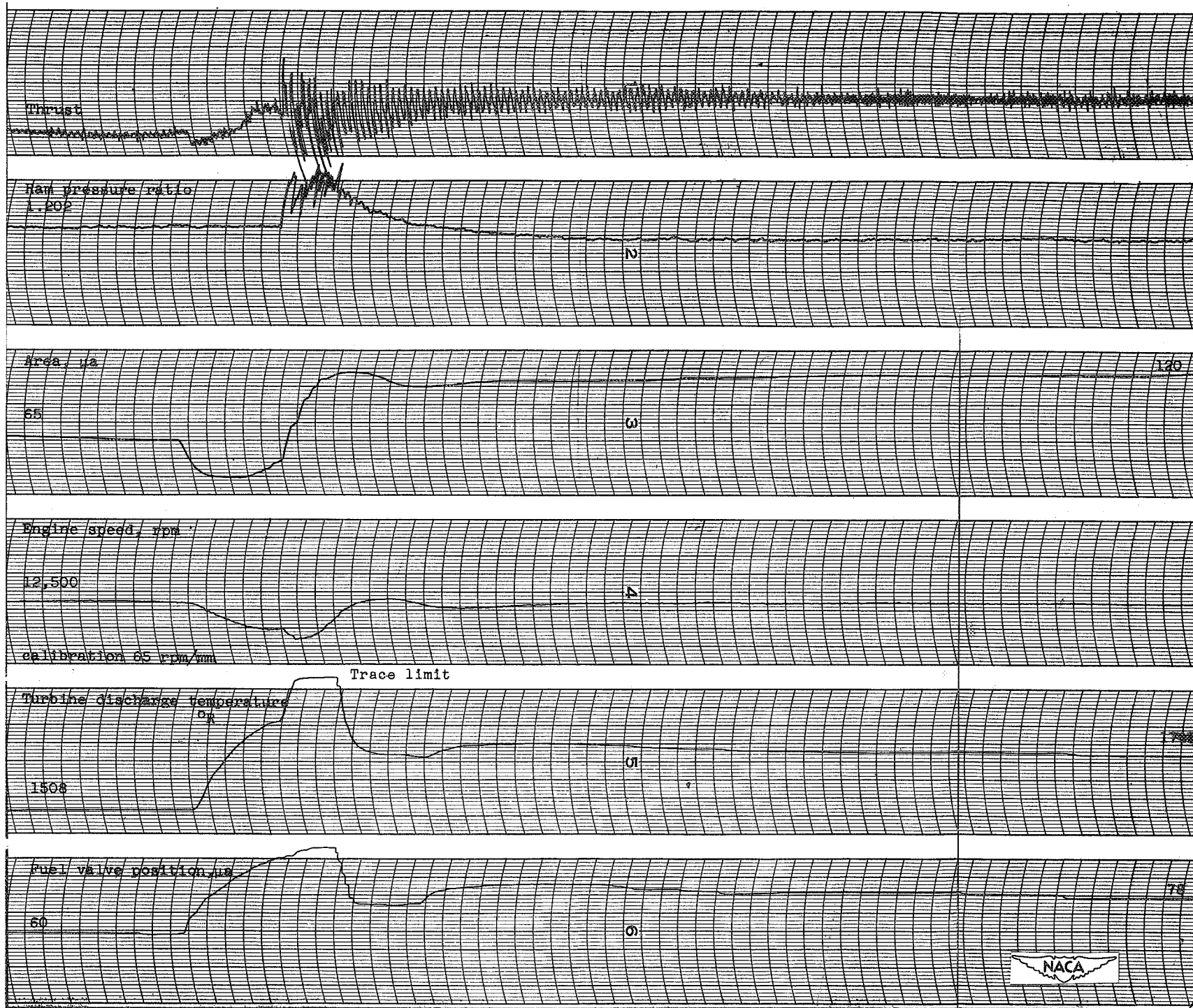


Figure 28. - Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 109° ; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

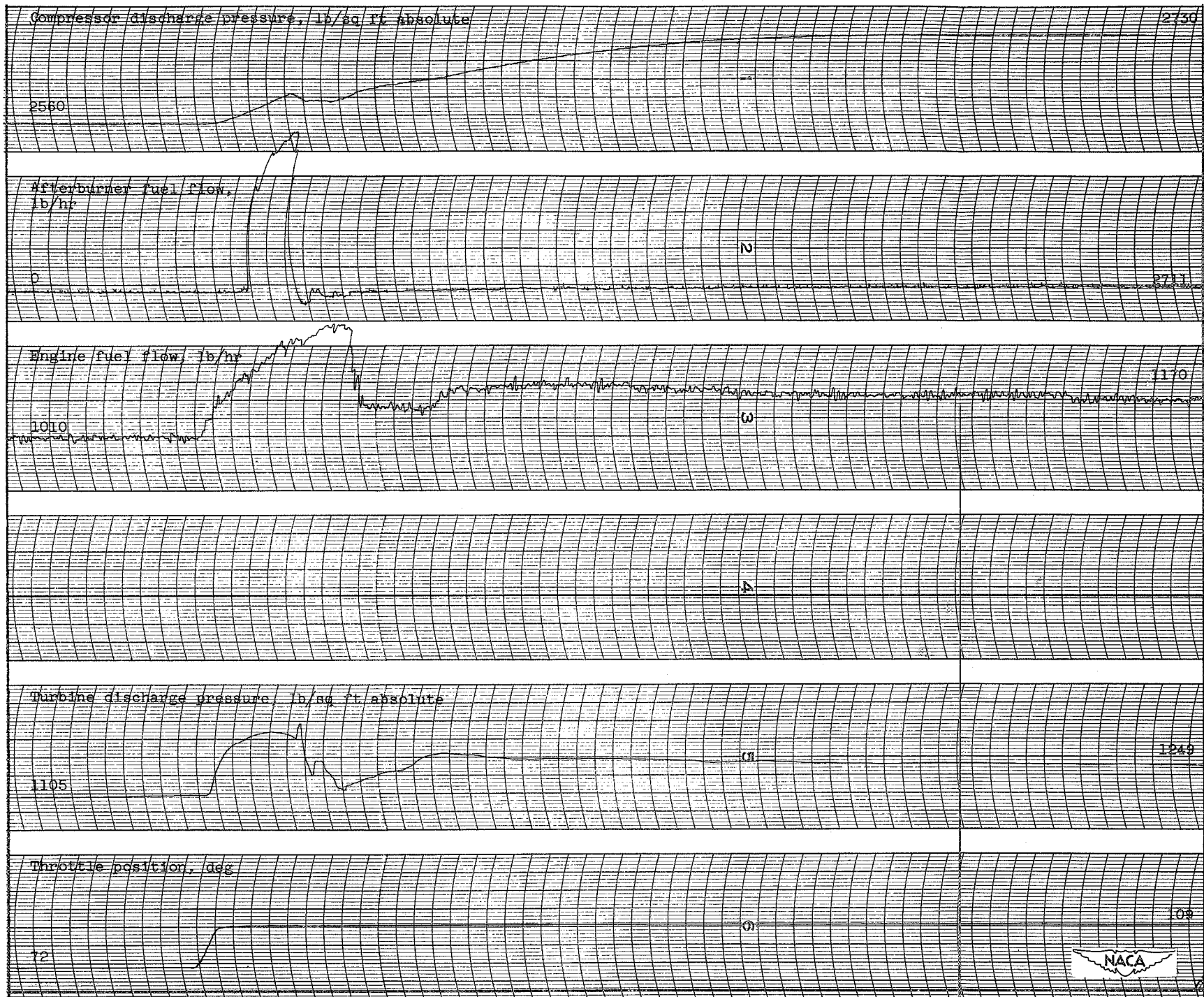


Figure 28. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 109° ; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

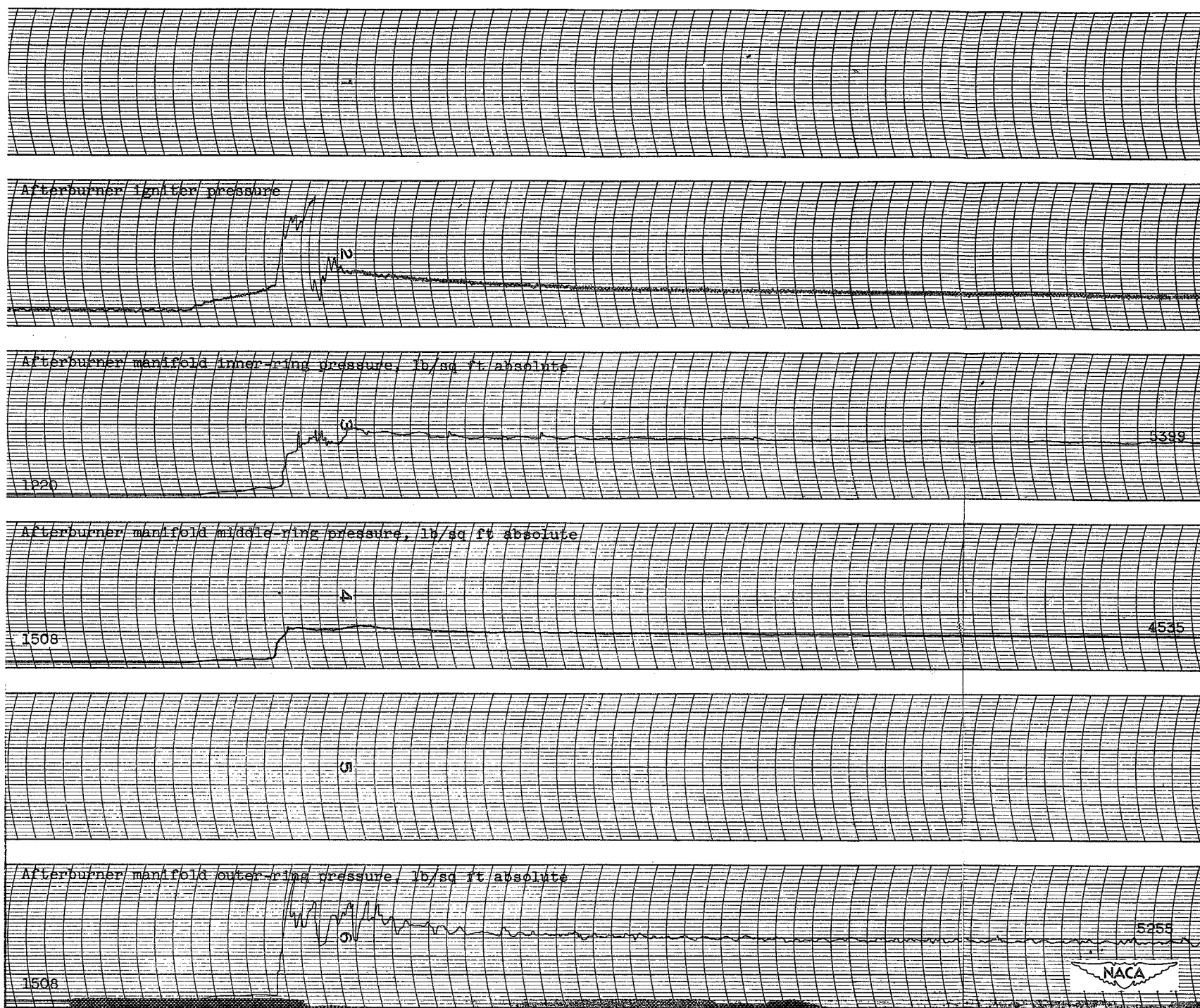


Figure 28. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 109° ; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

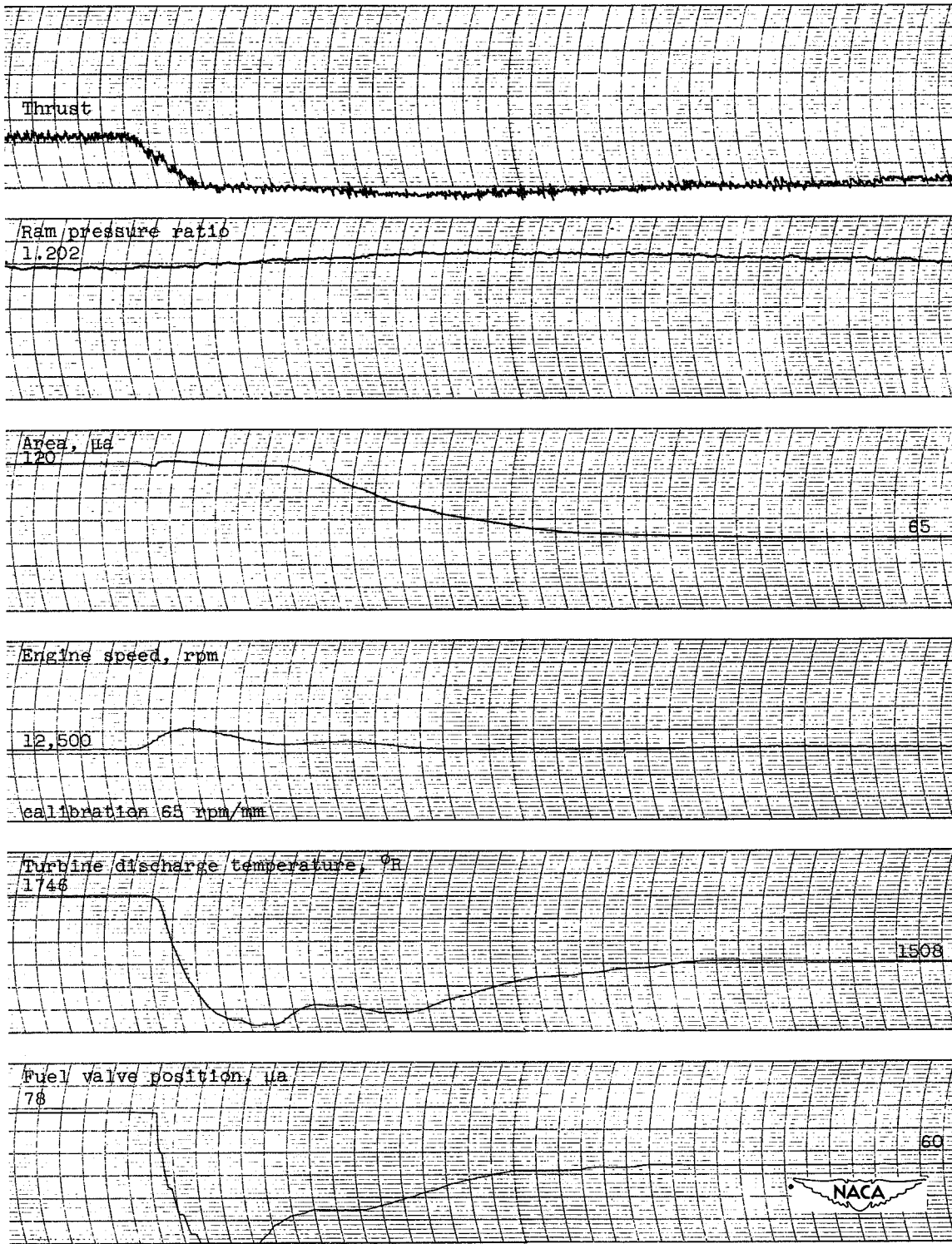


Figure 29. - Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 72° ; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

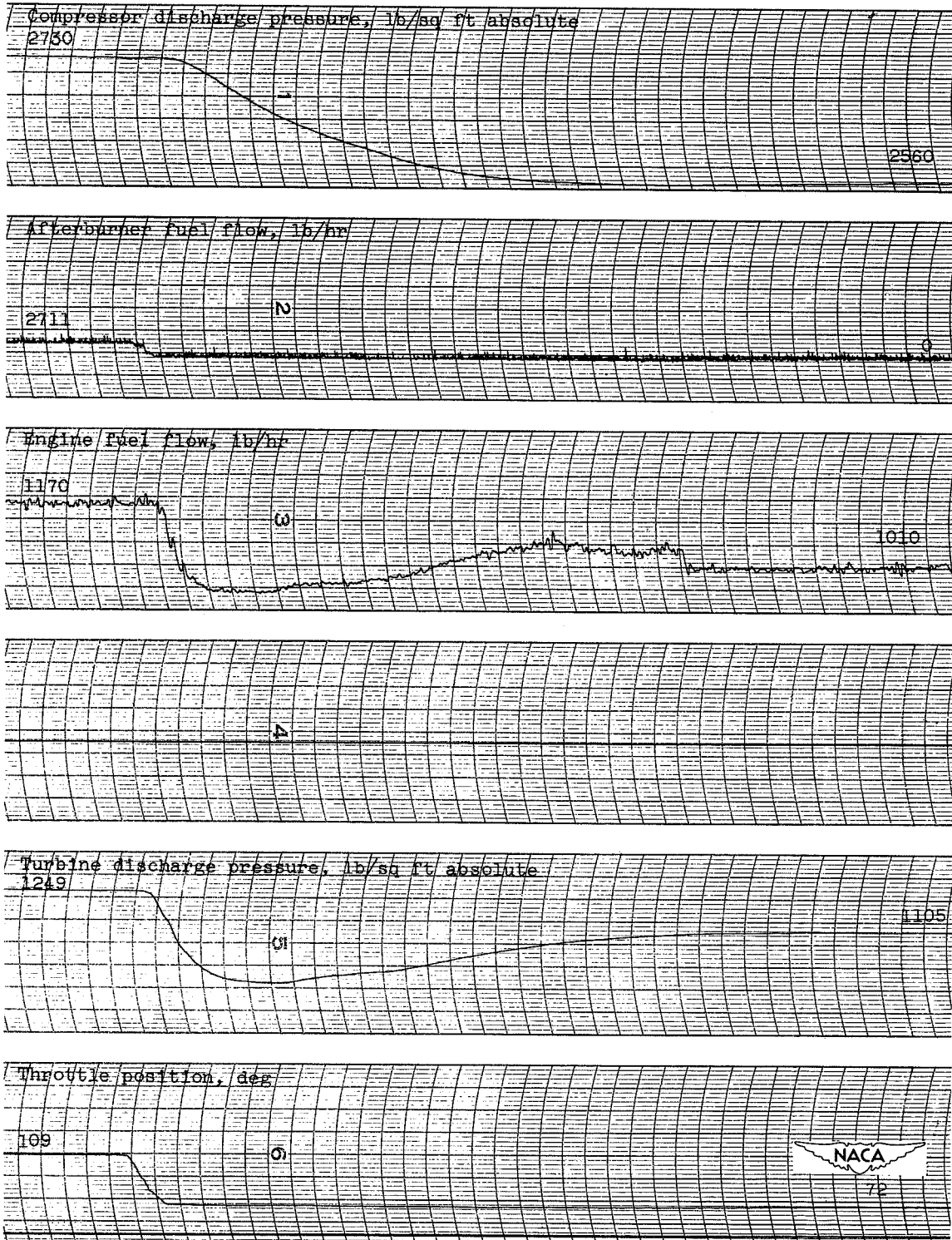


Figure 29. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 72°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

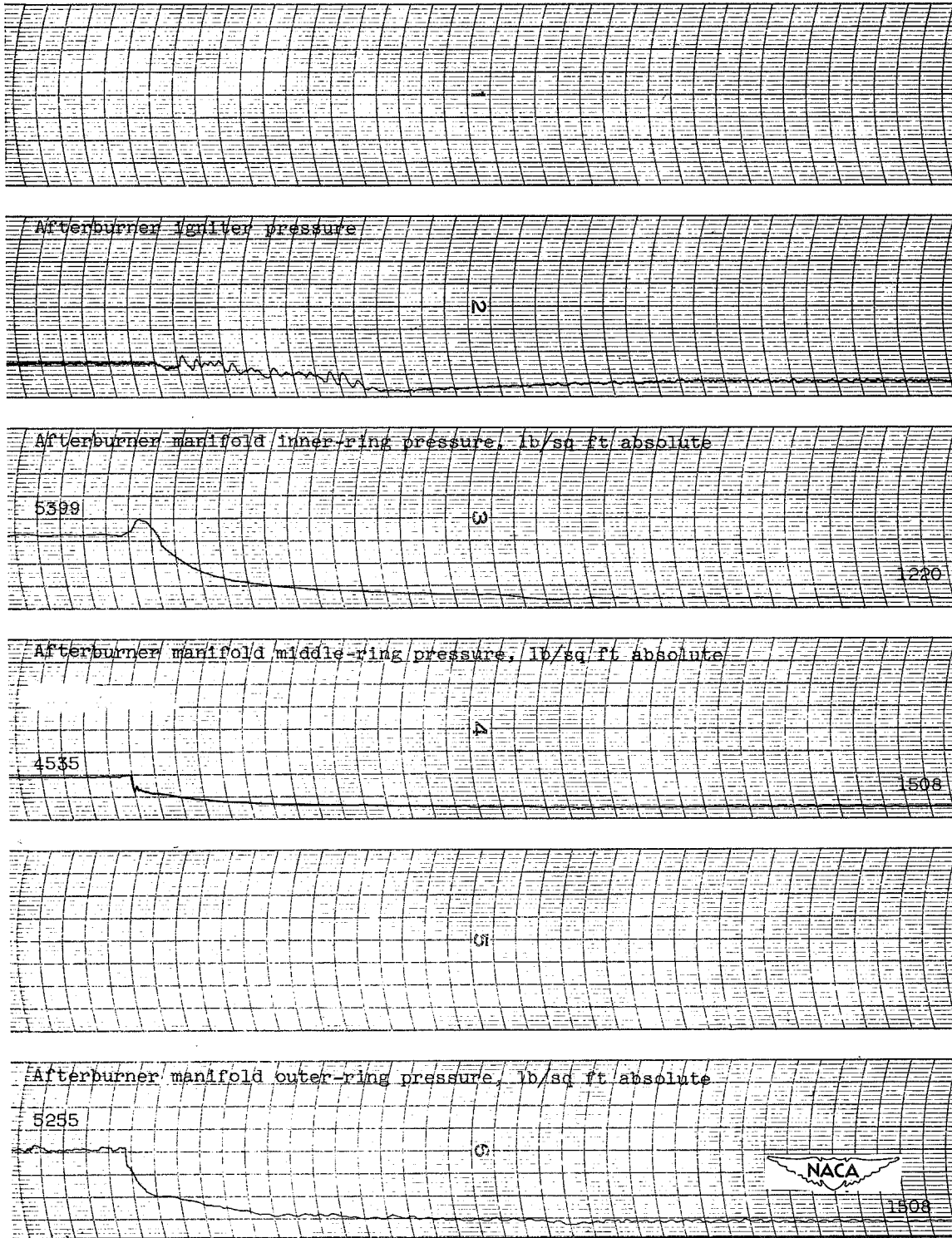


Figure 29. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 72°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

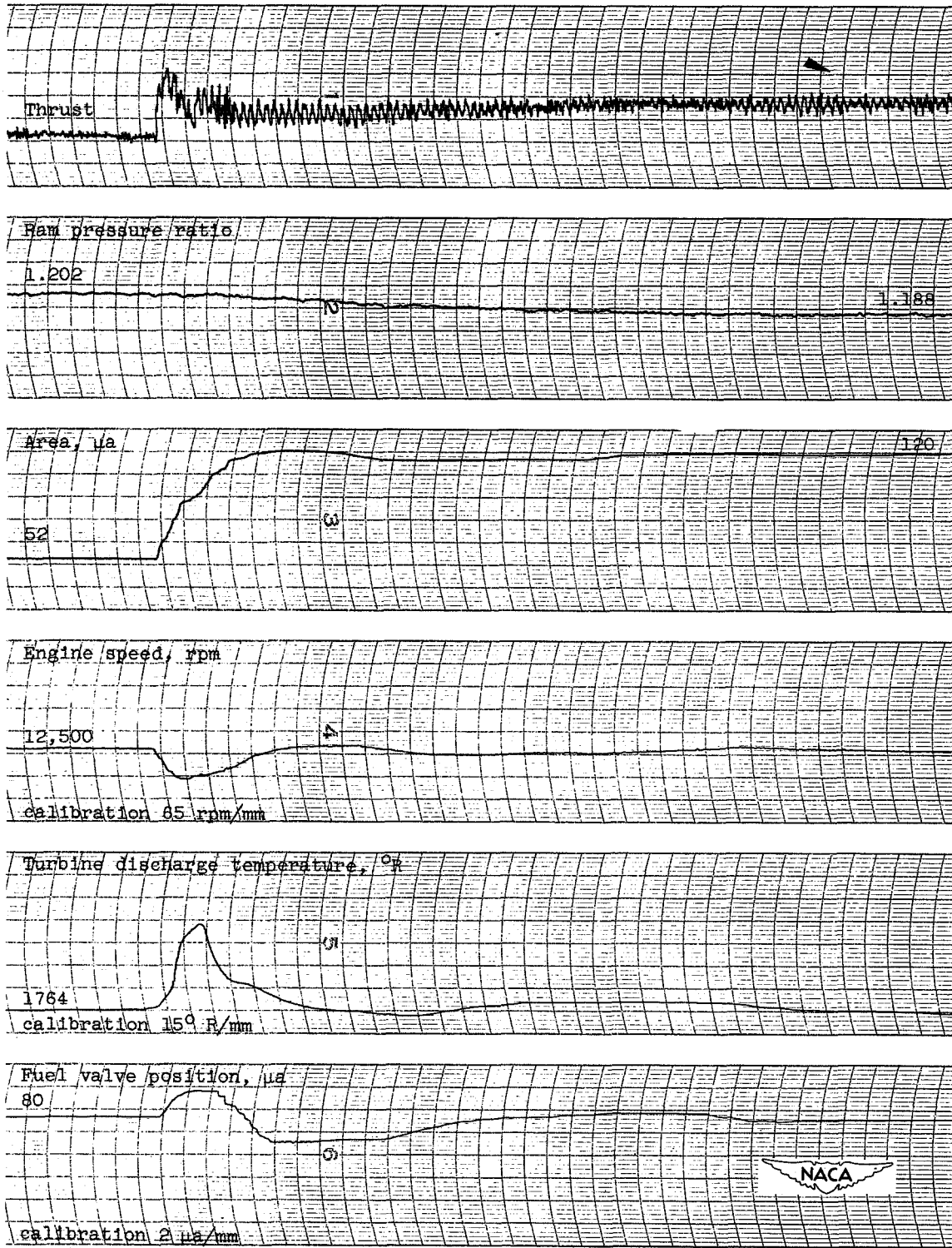


Figure 30. - Transient operation of automatically controlled engine with after-burner. Throttle position, 82 $^{\circ}$ to 108 $^{\circ}$; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

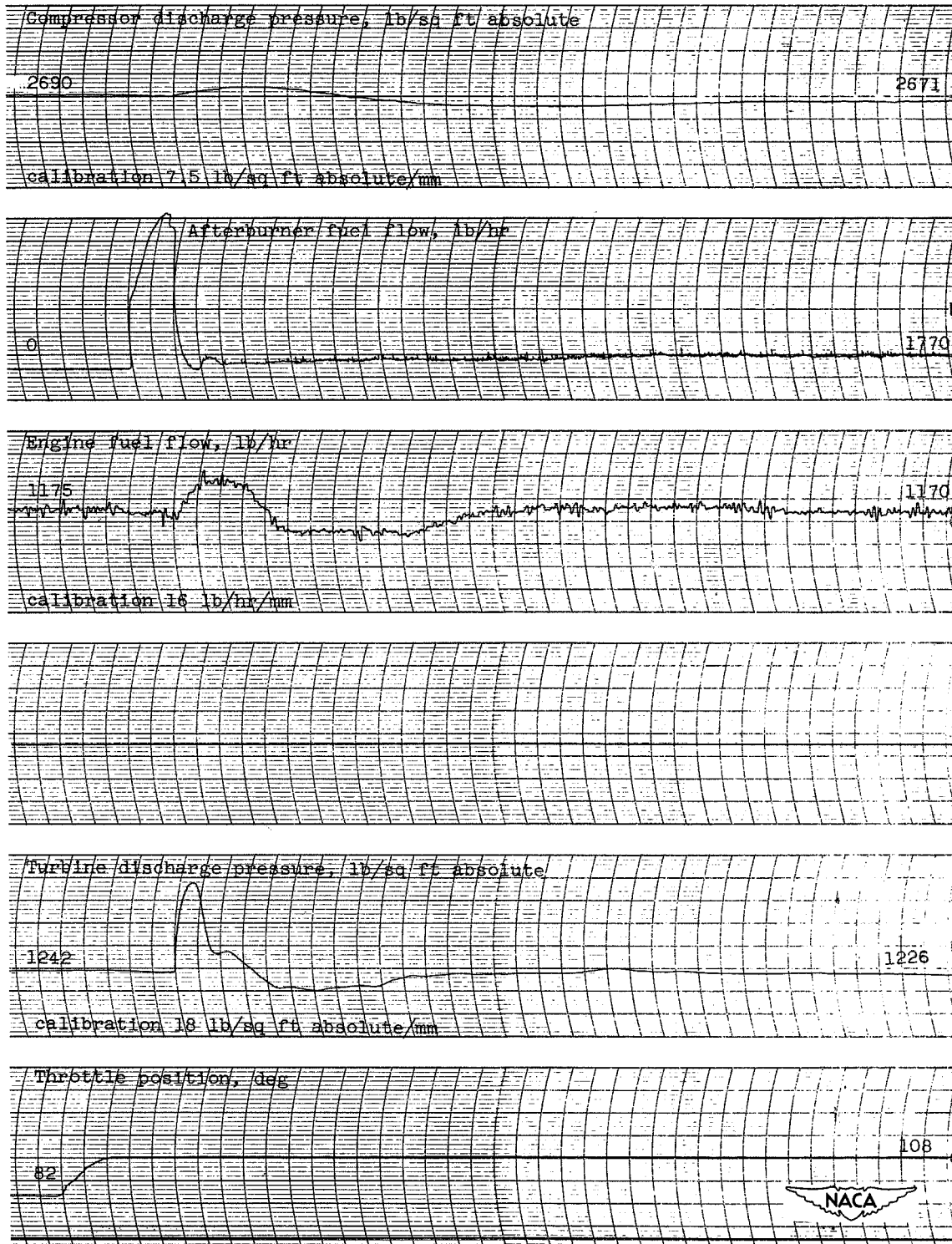


Figure 30. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 108°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

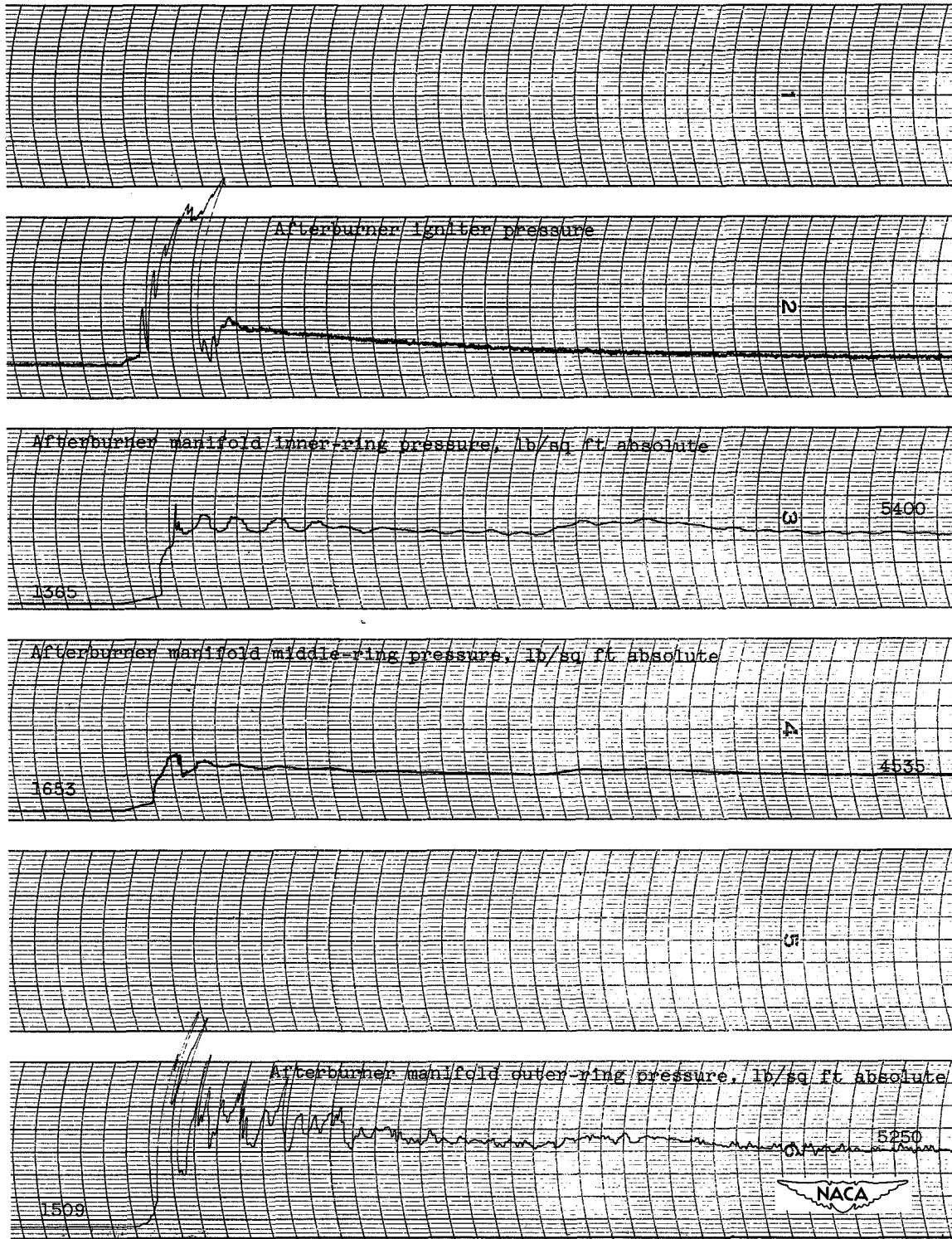


Figure 30. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 108°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

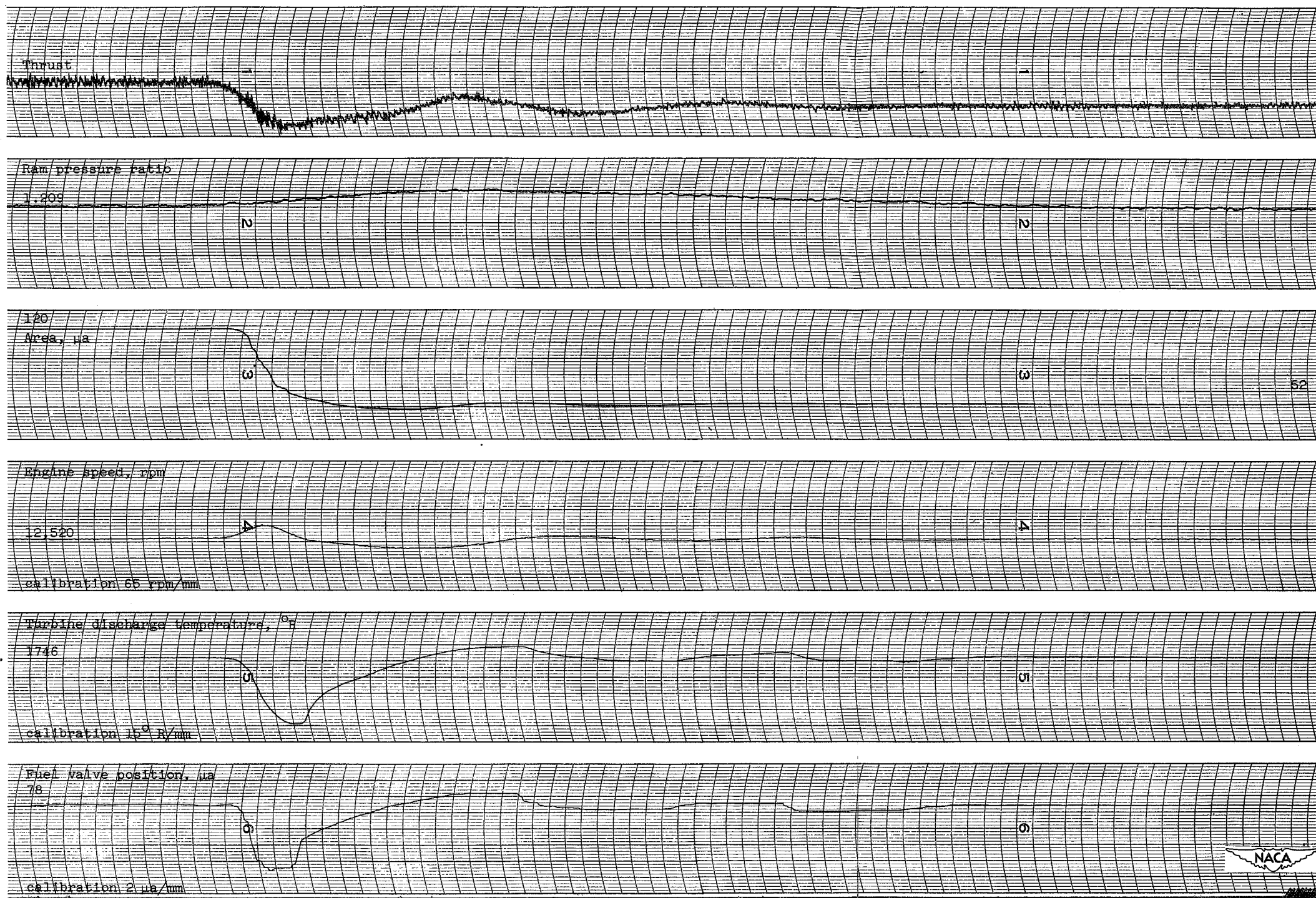


Figure 31. - Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 85°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

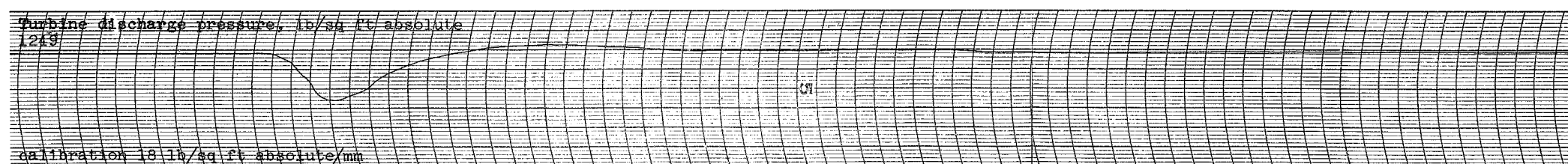
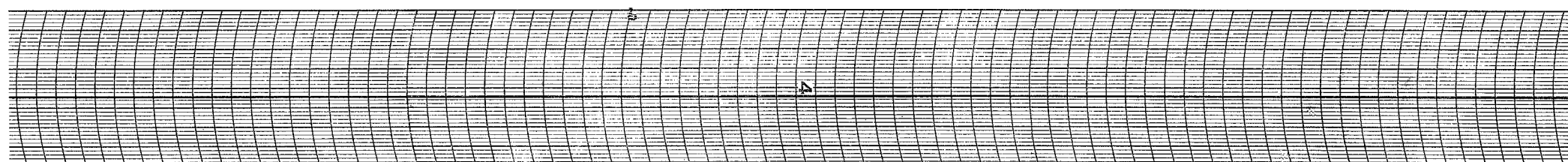
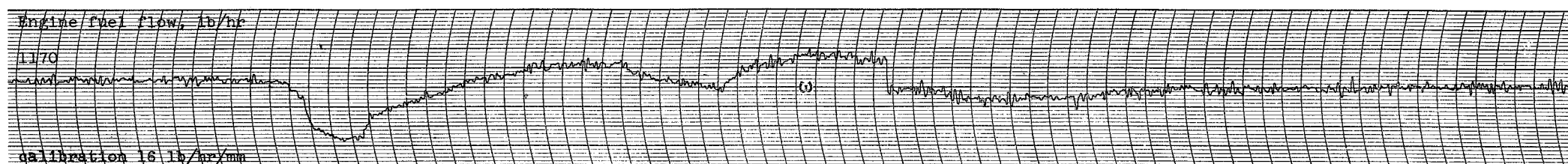
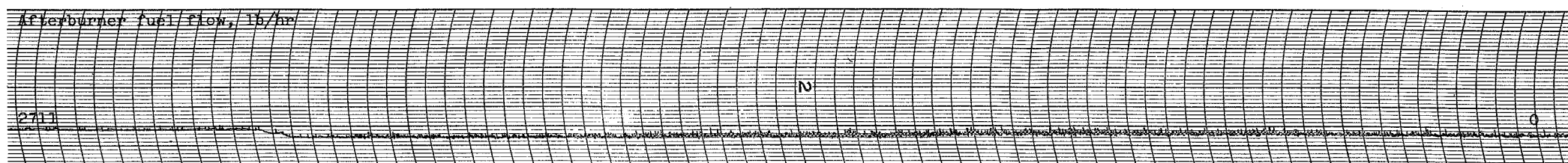
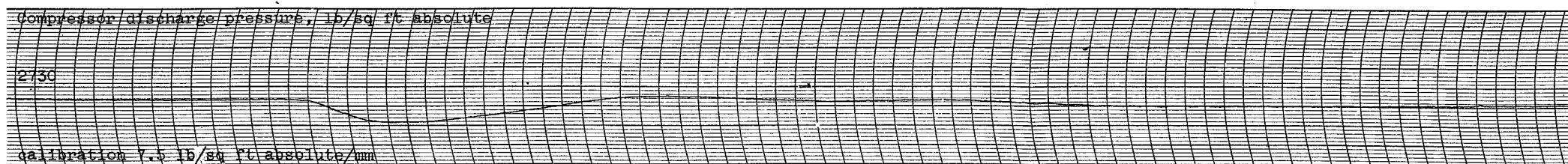


Figure 31. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 85°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

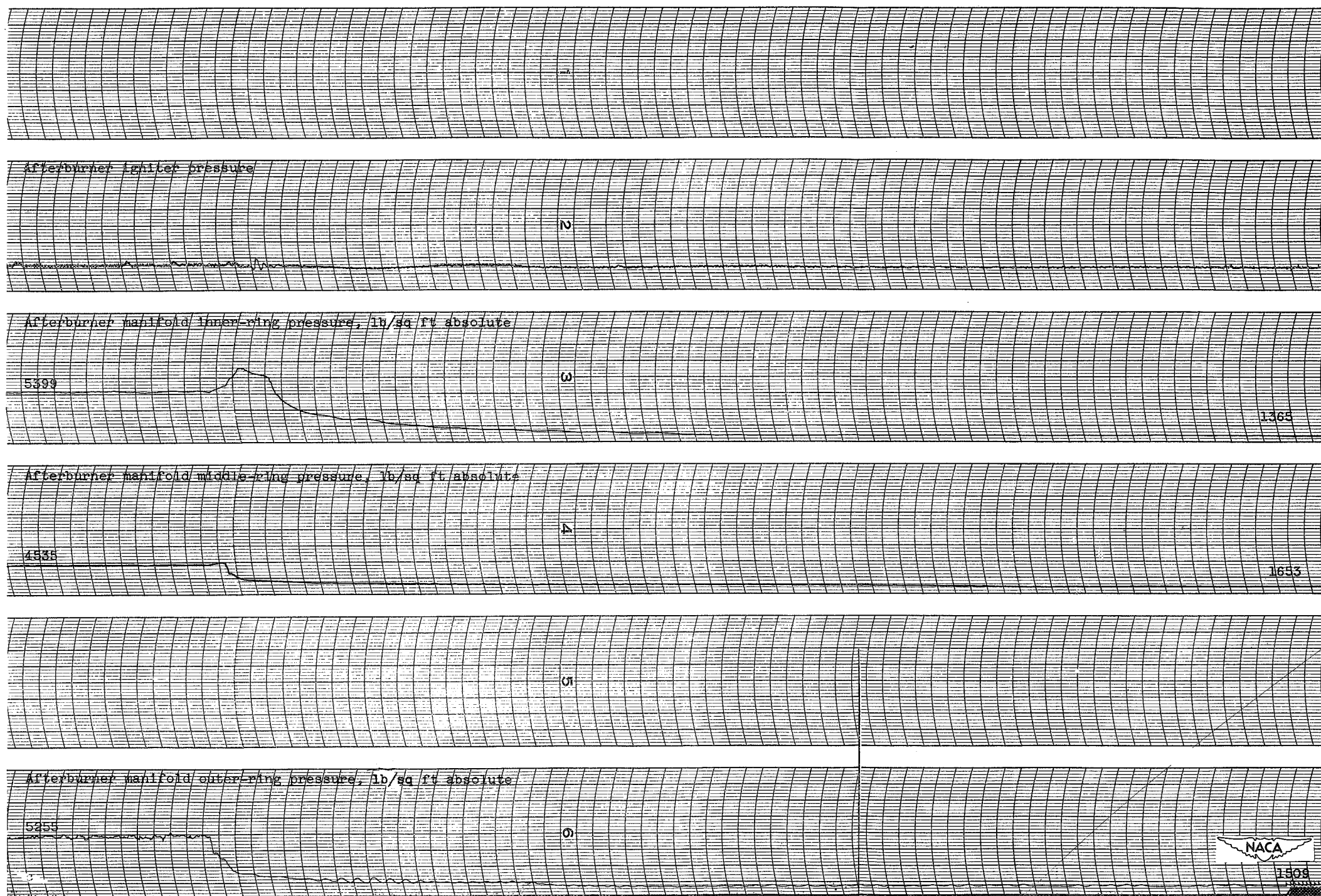


Figure 31. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 85°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

1107

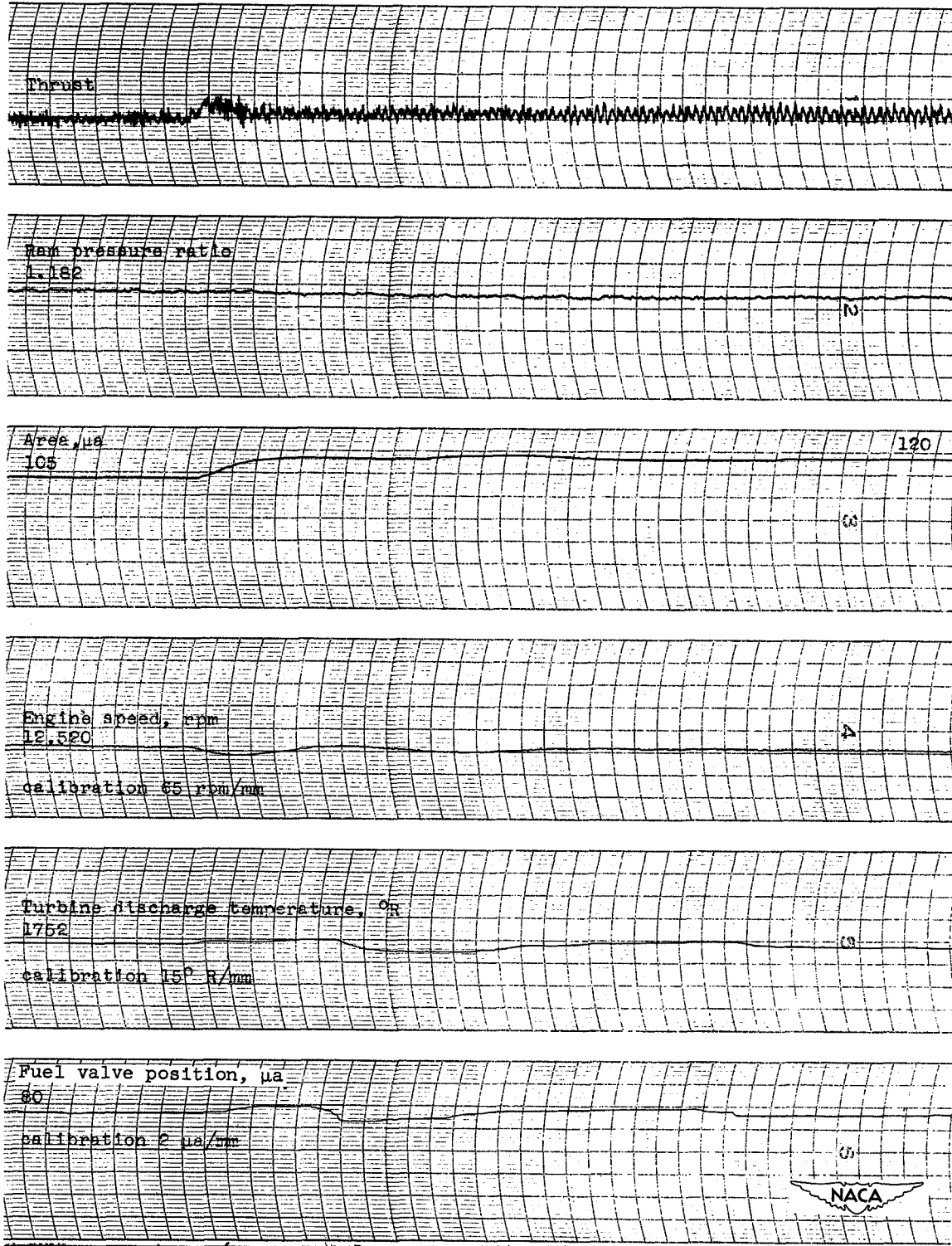


Figure 32. - Transient operation of automatically controlled engine with afterburner. Throttle position, 106° to 109°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

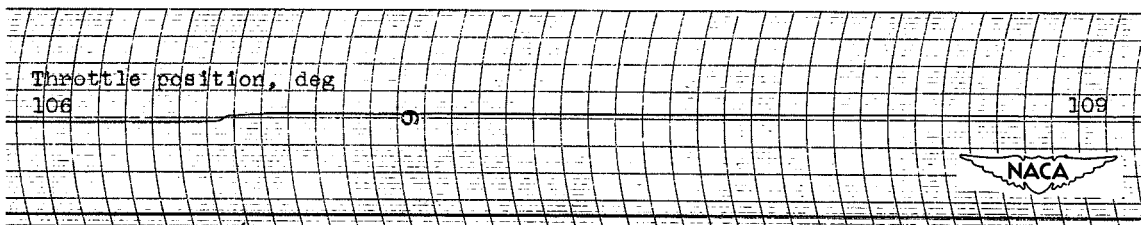
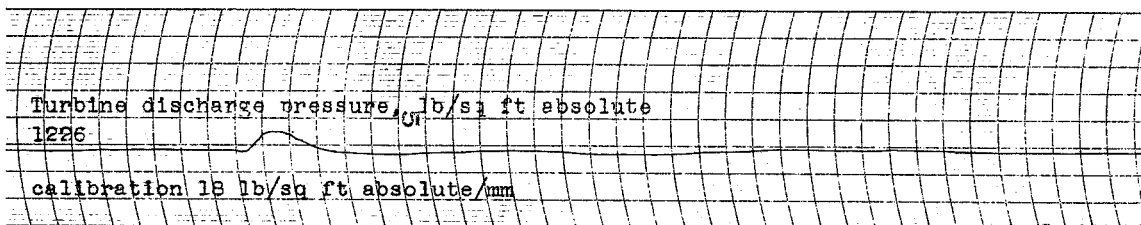
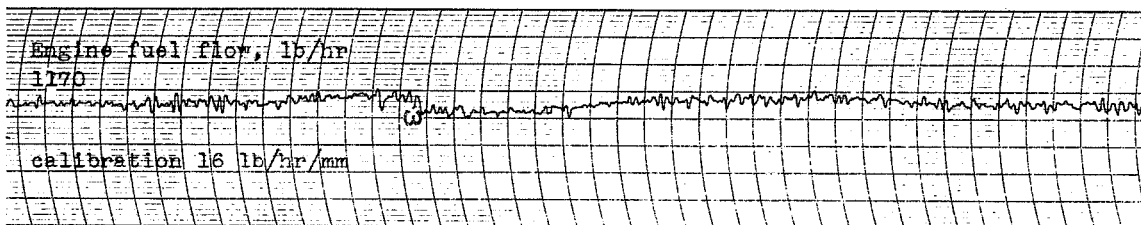
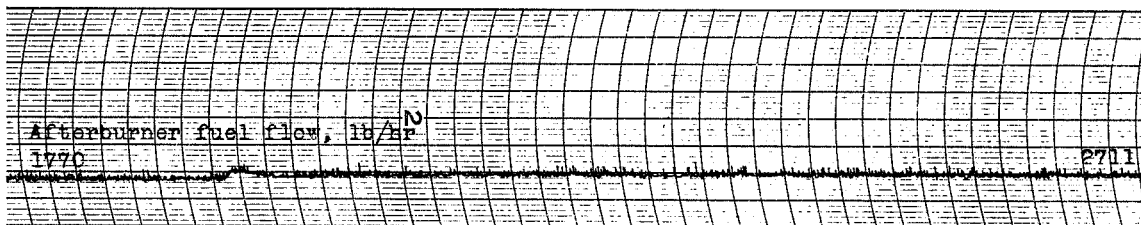
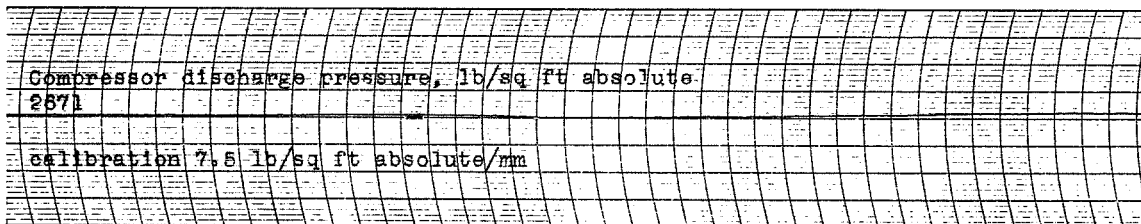


Figure 32. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 106° to 109°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

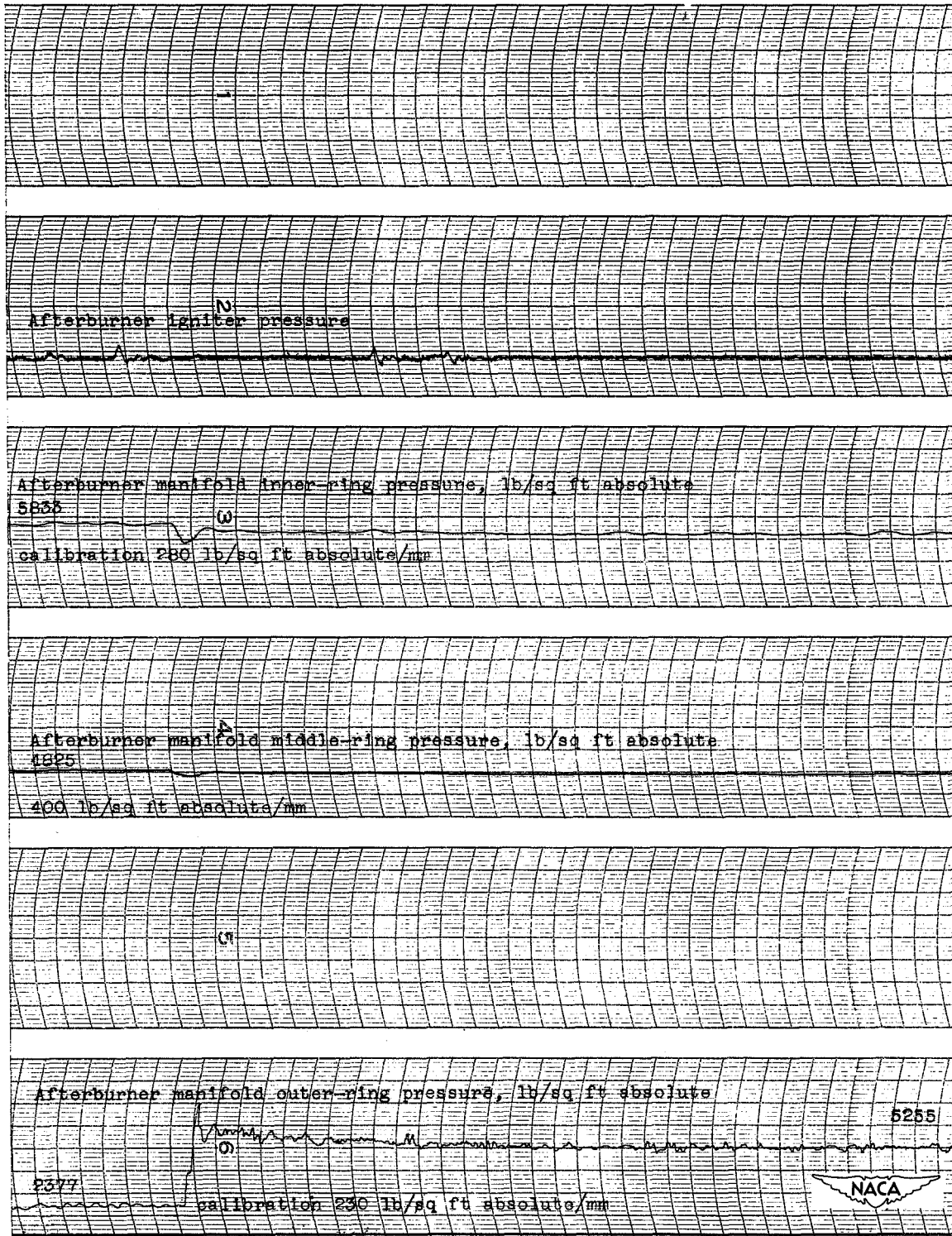


Figure 32. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 106° to 109°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

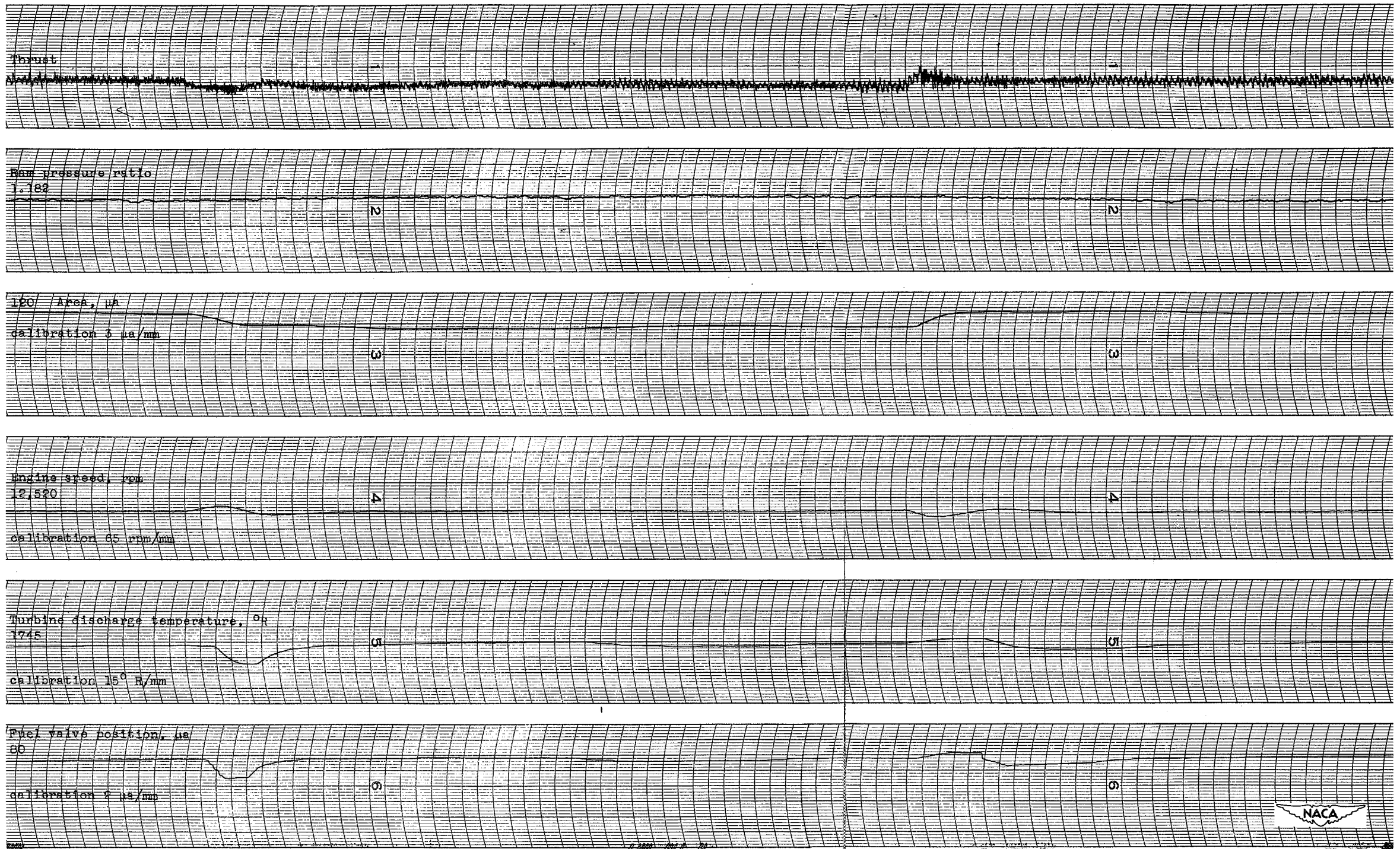


Figure 33. Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 101° and 101° to 109° ; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

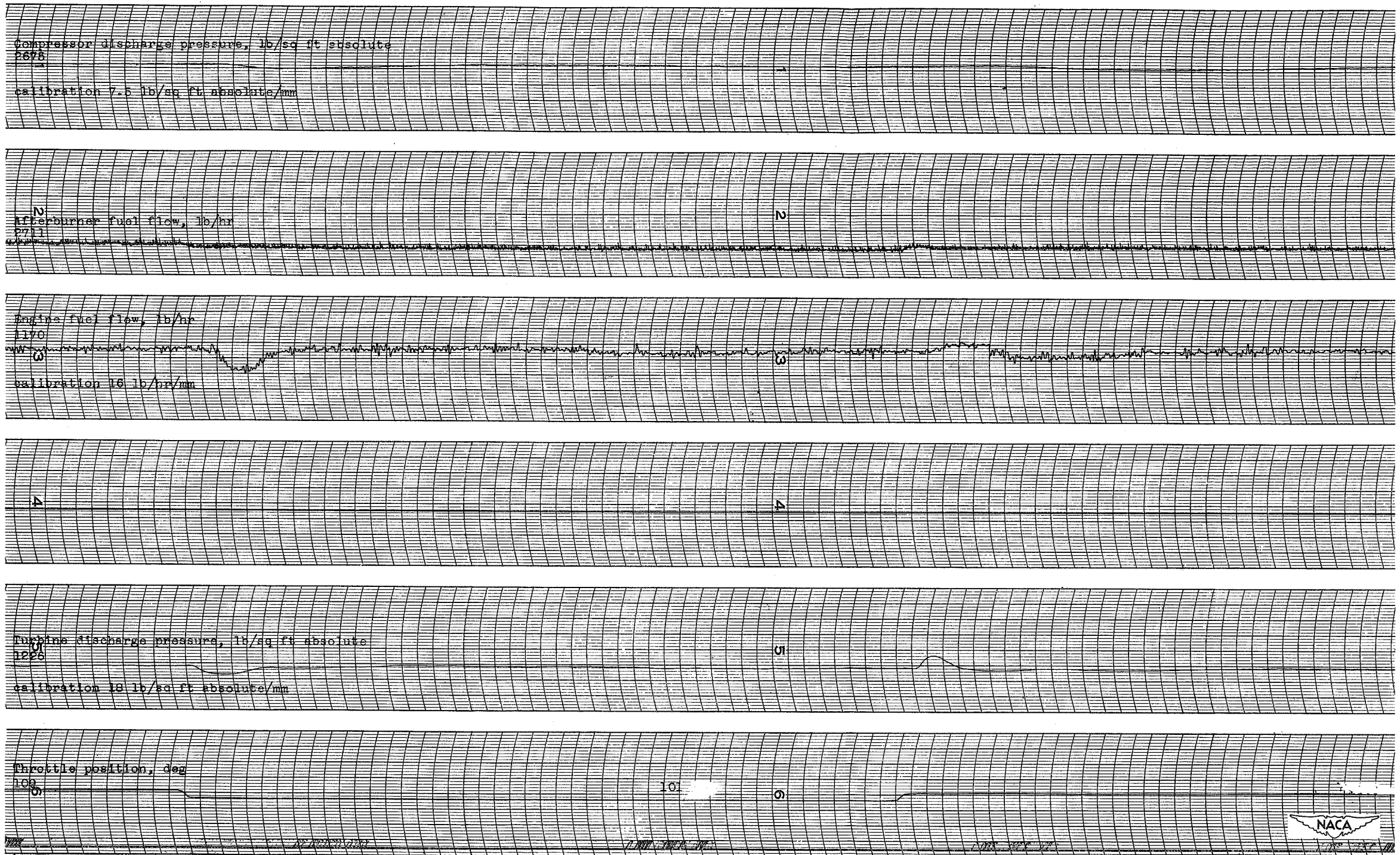


Figure 33. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 101° and 101° to 109°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

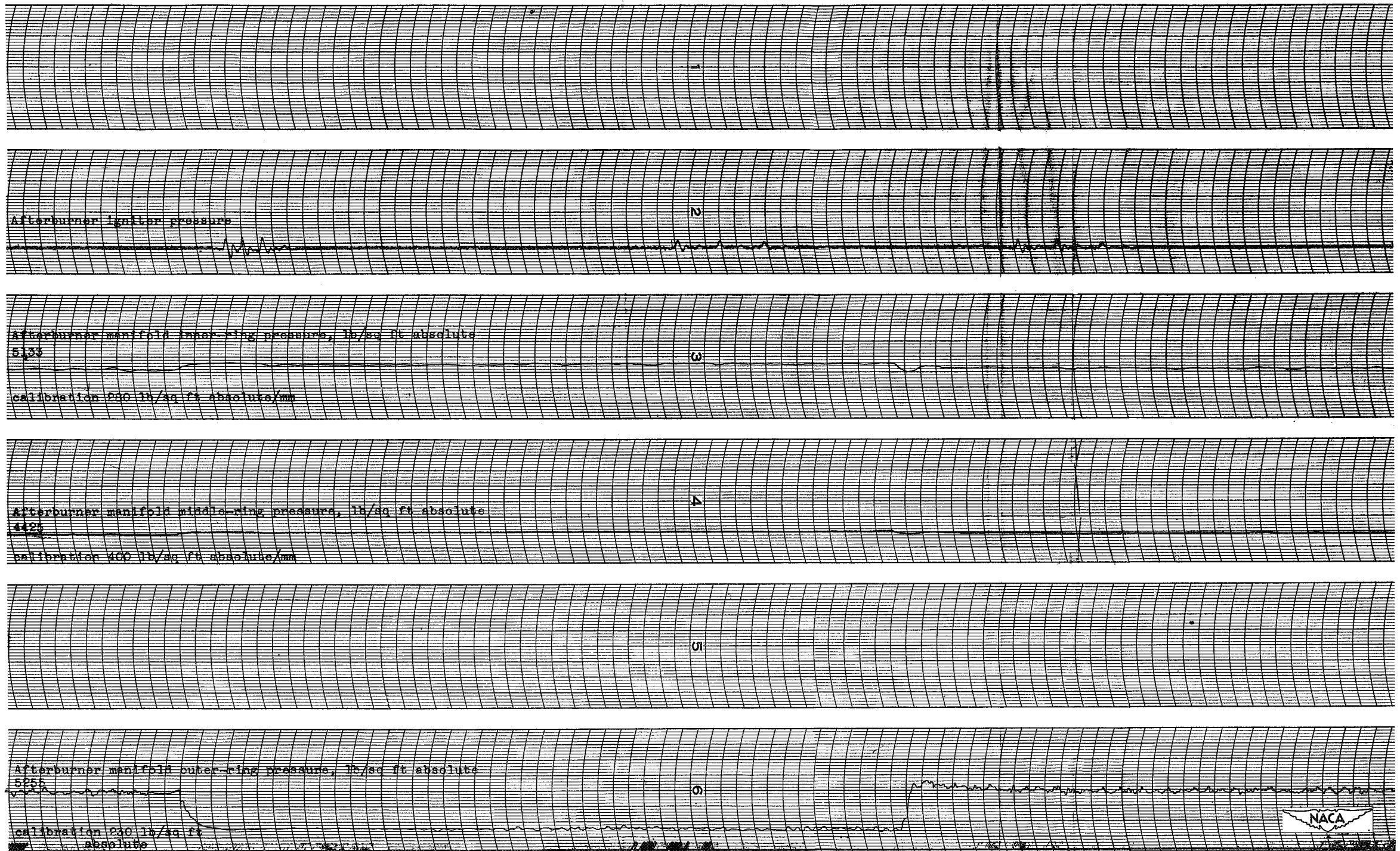


Figure 33. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 101° and 101° to 109°; altitude, 35,000 feet
nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

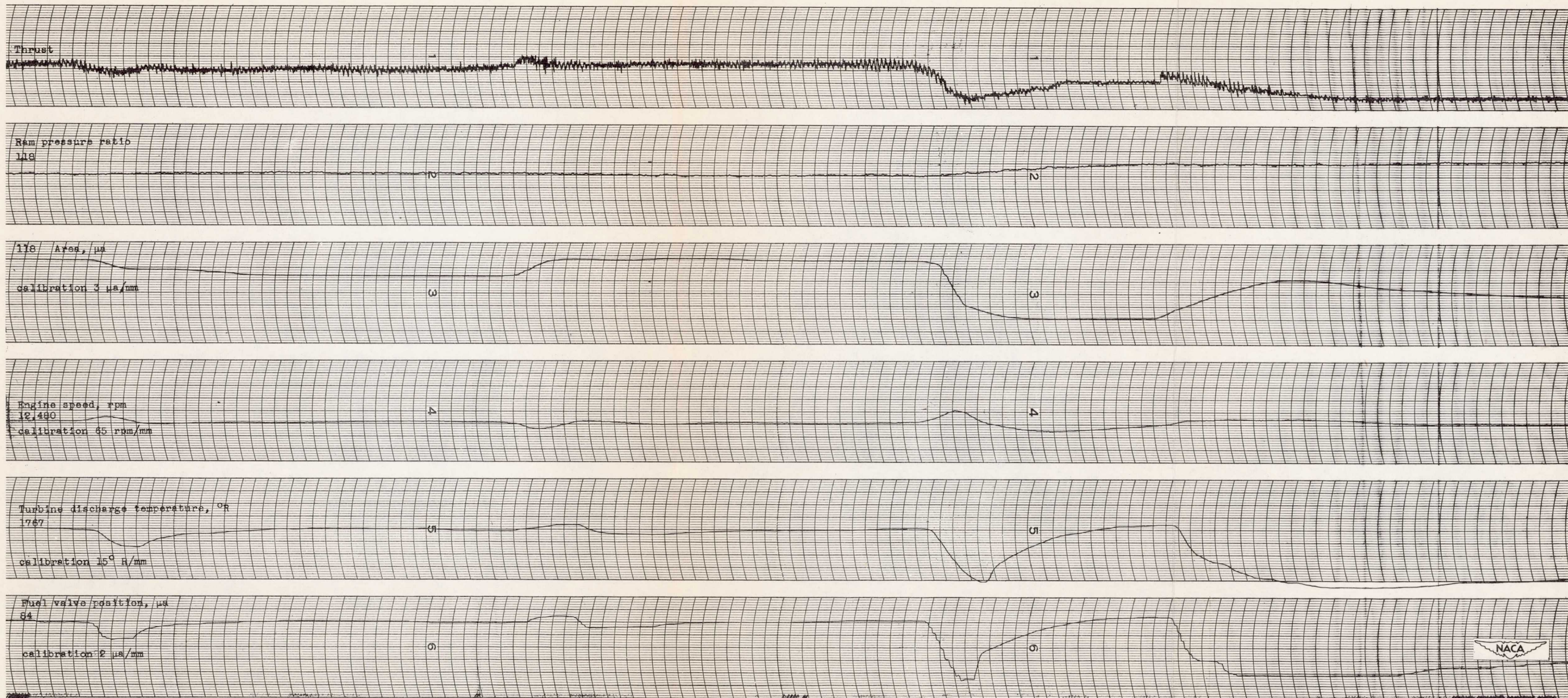


Figure 34. - Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 97°, 97° to 109°, 109° to 93°, and 93° to 75°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

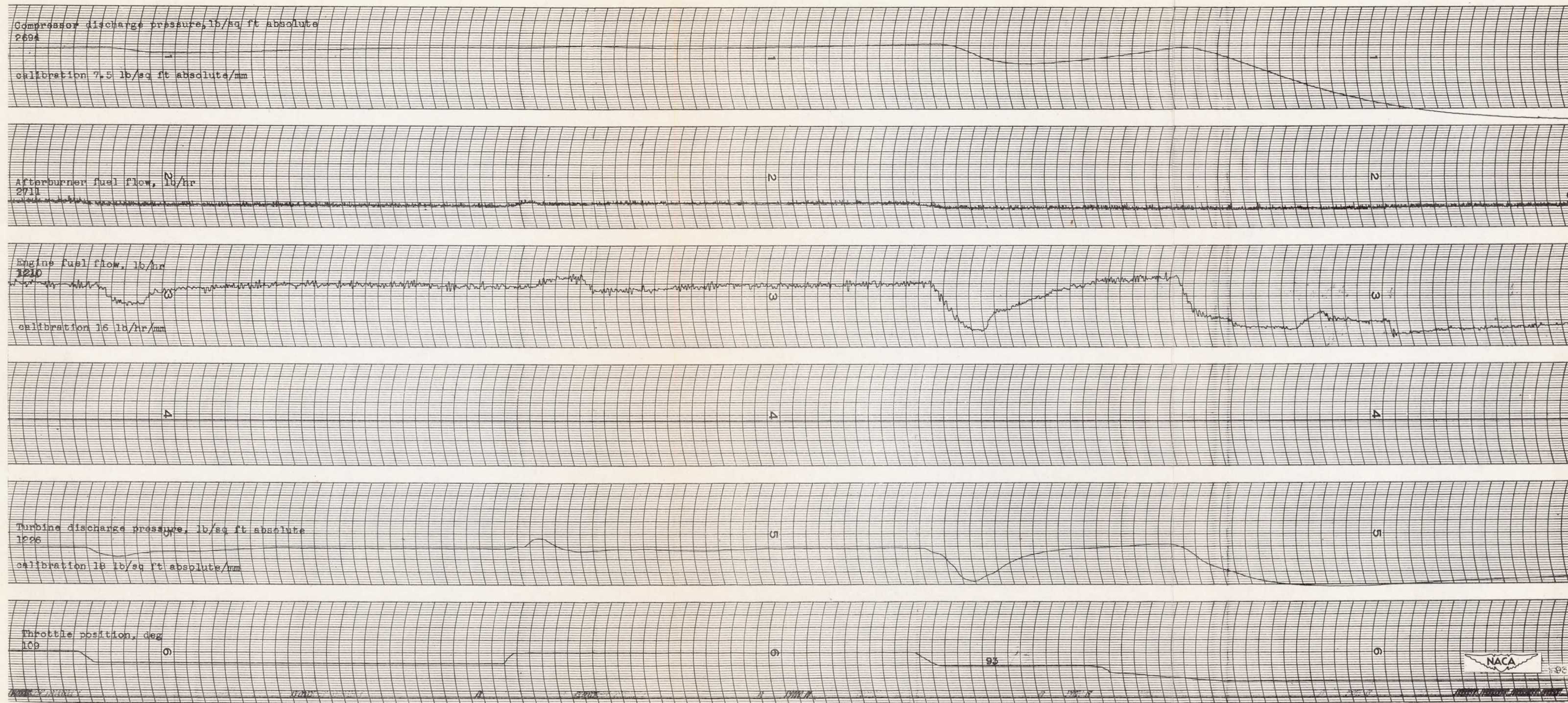


Figure 34. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 97°, 97° to 109°, 109° to 93° and 93° to 75°; altitude, 35,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

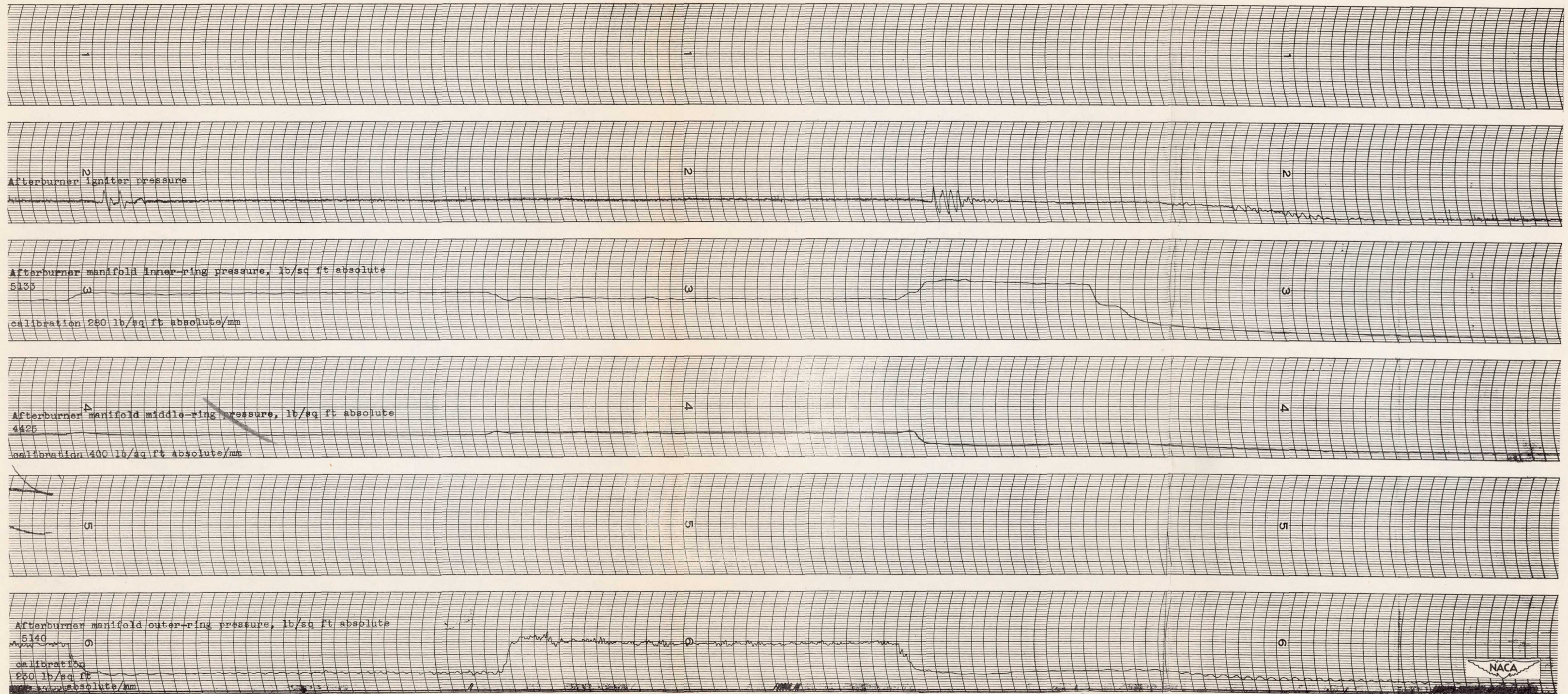


Figure 34. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 97°, 97° to 109°, 109° to 93° and 93° to 75° altitude, 35,000 feet, nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

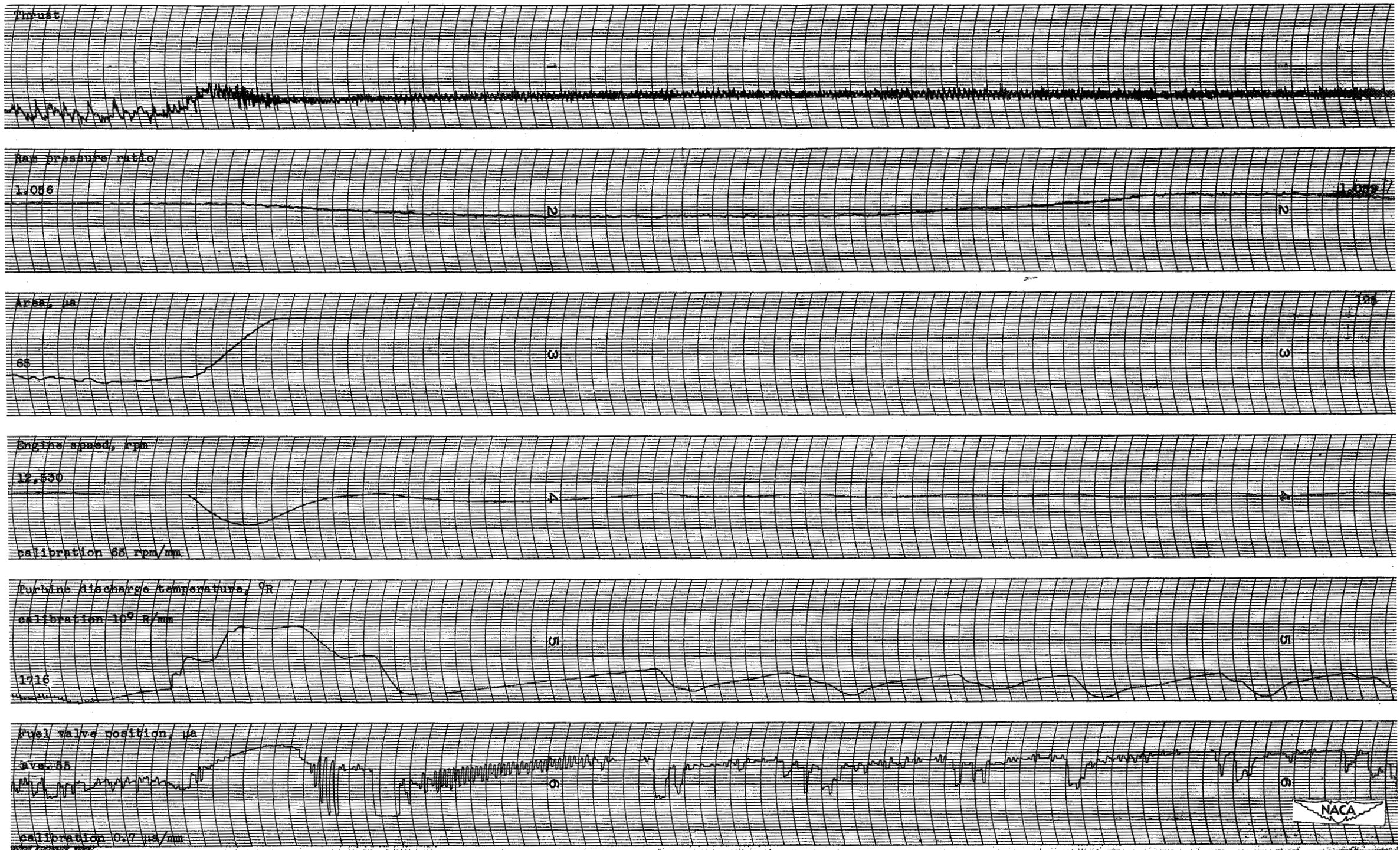


Figure 35. - Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 108°; altitude, 40,000 feet; nominal ram pressure ratio, 1.05; boost pump inlet pressure, 26 pounds per square inch.

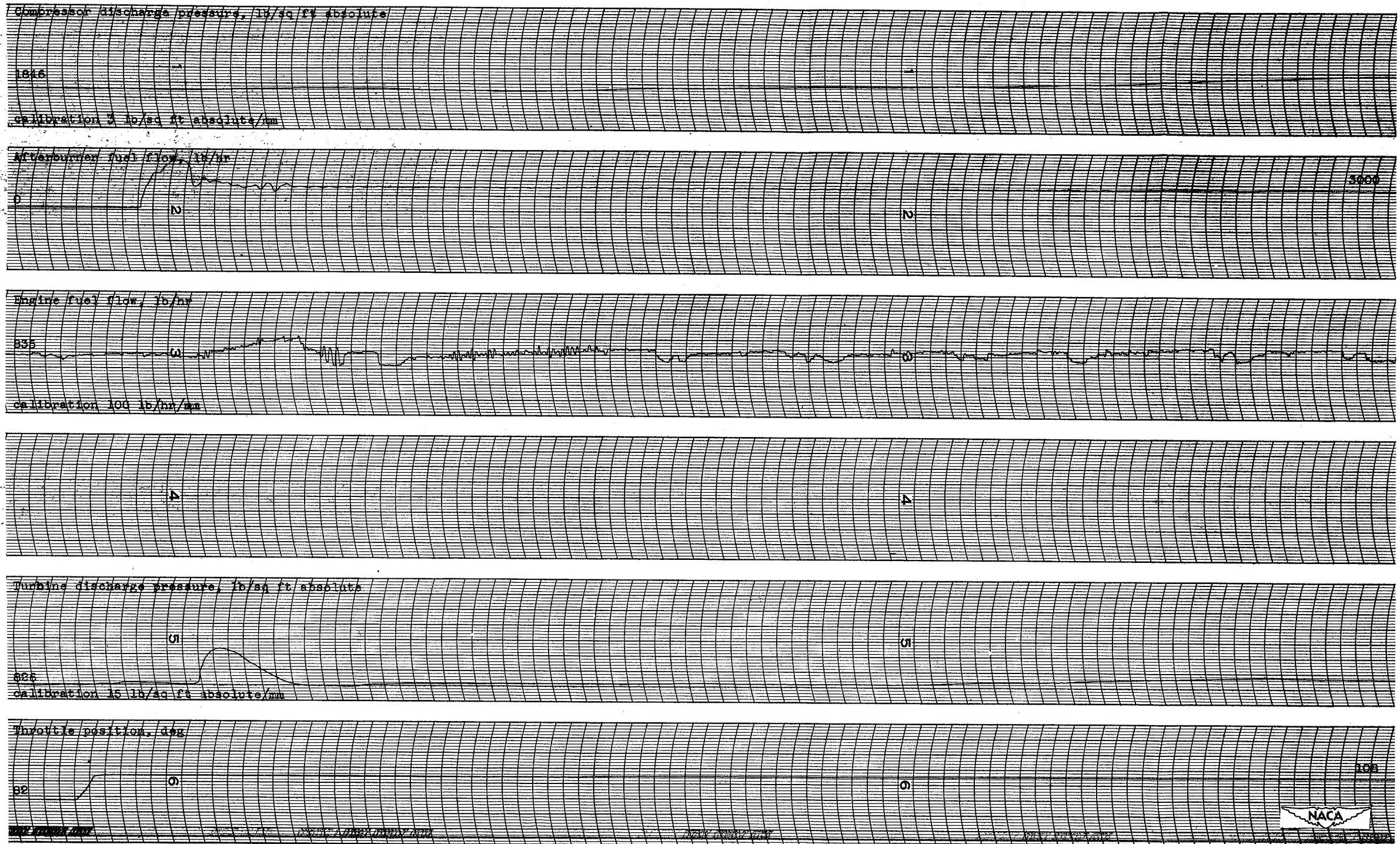


Figure 35. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 108°; altitude, 40,000 feet; nominal ram pressure ratio, 1.05; boost pump inlet pressure, 26 pounds per square inch.

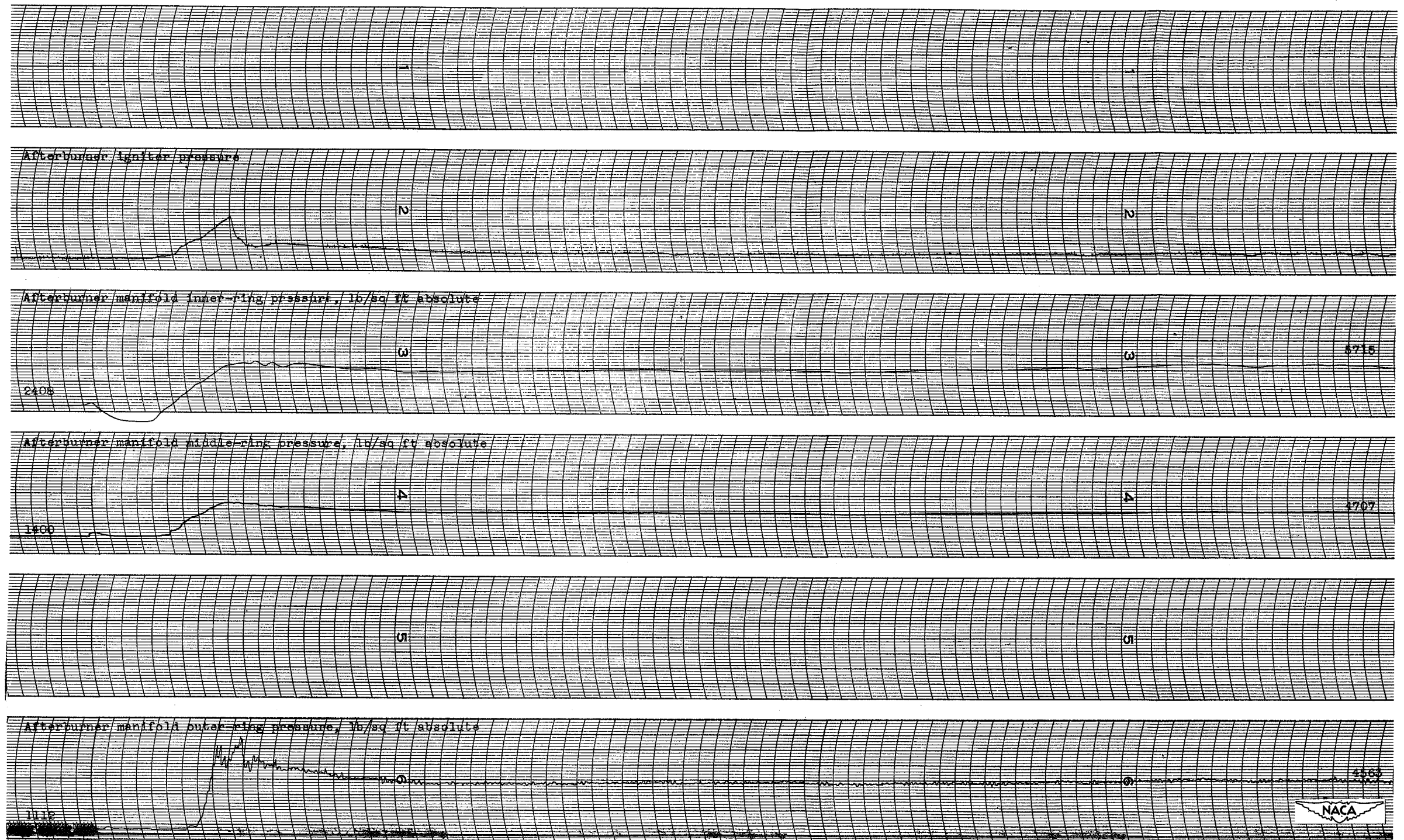


Figure 35. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 108°; altitude, 40,000 feet; nominal ram pressure ratio, 1.05; boost pump inlet pressure, 26 pounds per square inch.

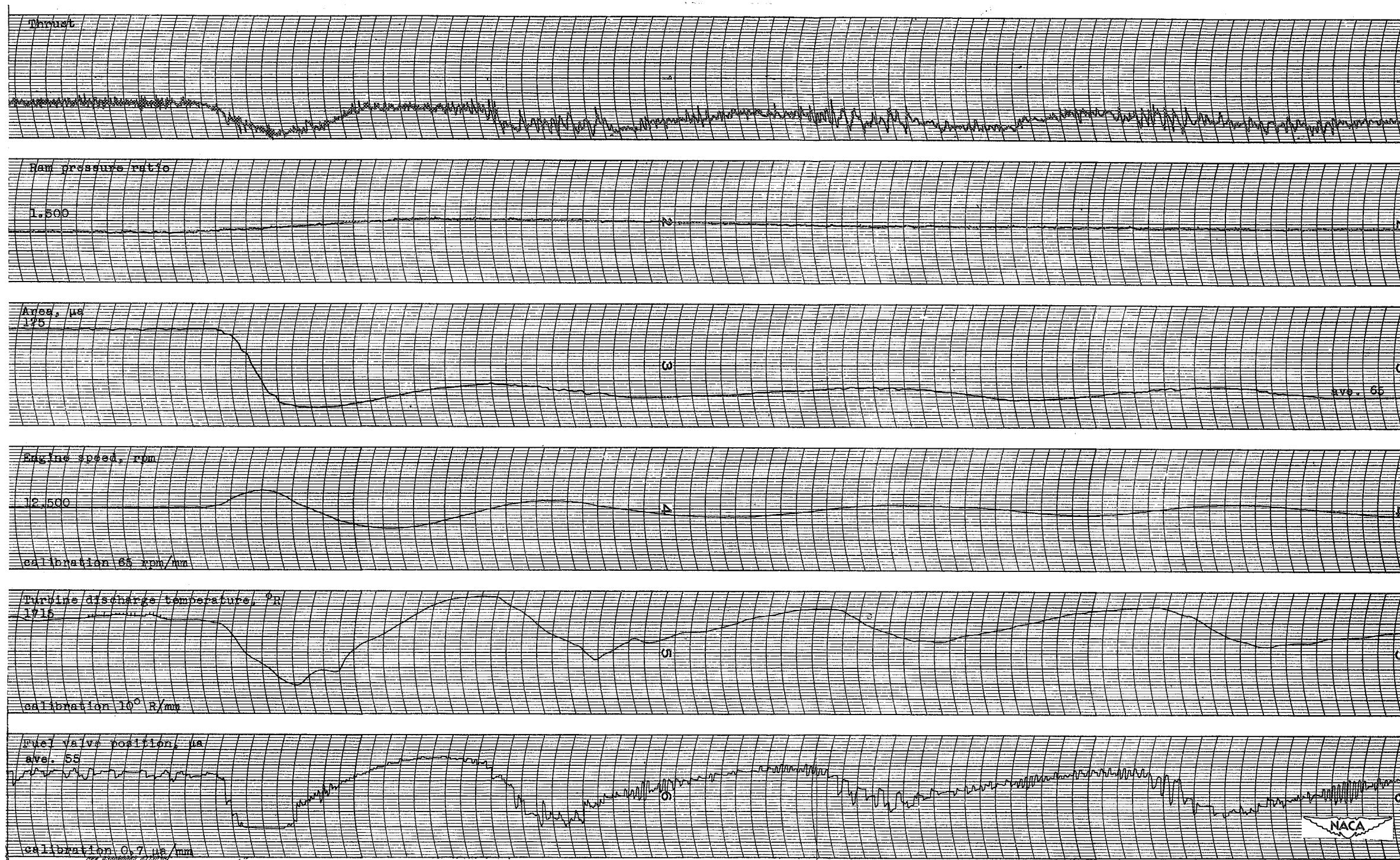


Figure 36. - Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 84°; altitude, 40,000 feet; nominal ram pressure ratio, 1.05; boost pump inlet pressure, 26 pounds per square inch.

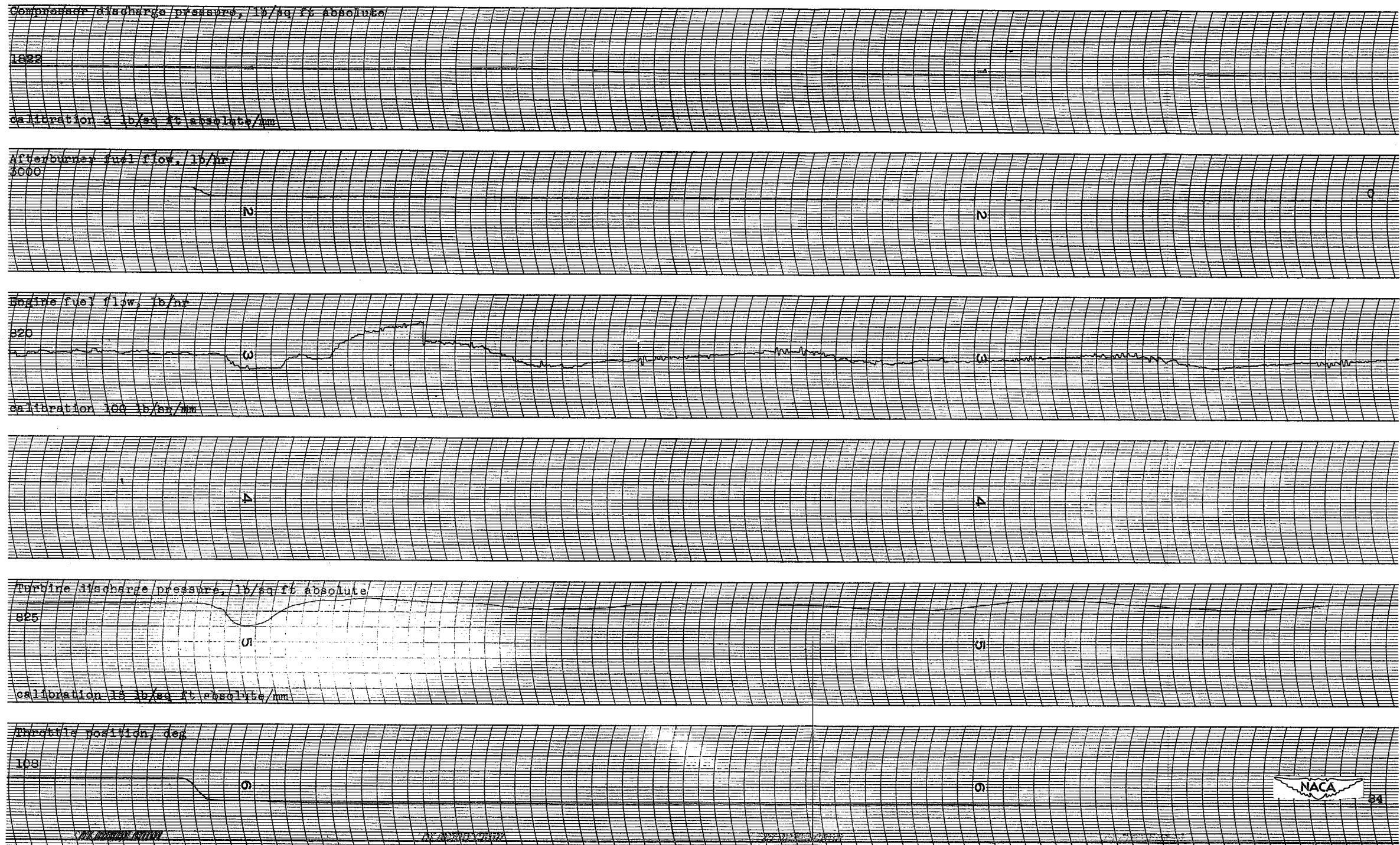


Figure 36. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 84°; altitude, 40,000 feet; nominal ram pressure ratio, 1.05; boost pump inlet pressure, 26 pounds per square inch.

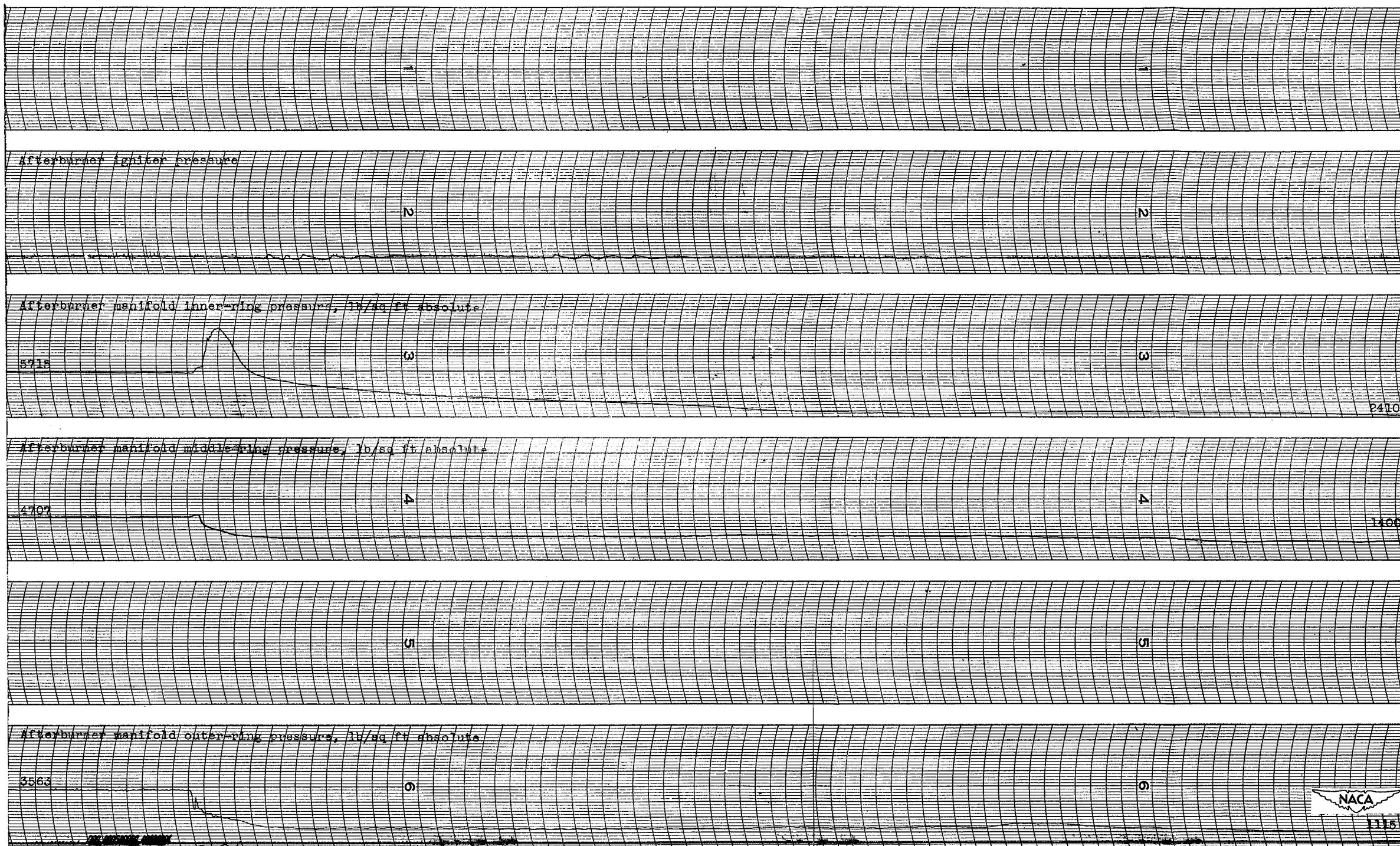


Figure 36. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 84°; altitude, 40,000 feet; nominal ram pressure ratio, 1.05; boost pump inlet pressure, 26 pounds per square inch.

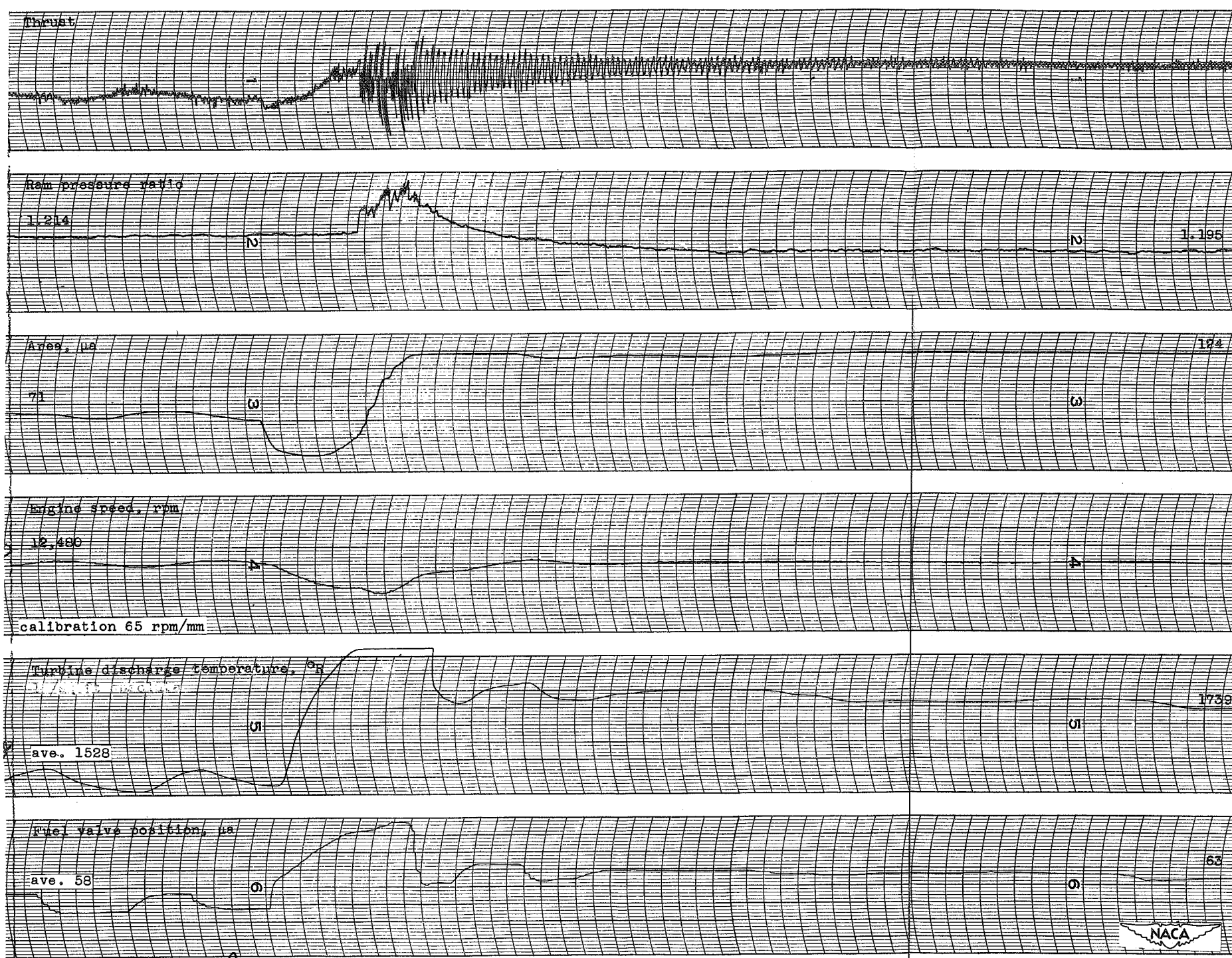


Figure 37. - Transient operation of automatically controlled engine with afterburner. Throttle position, 73° to 108° ; altitude 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

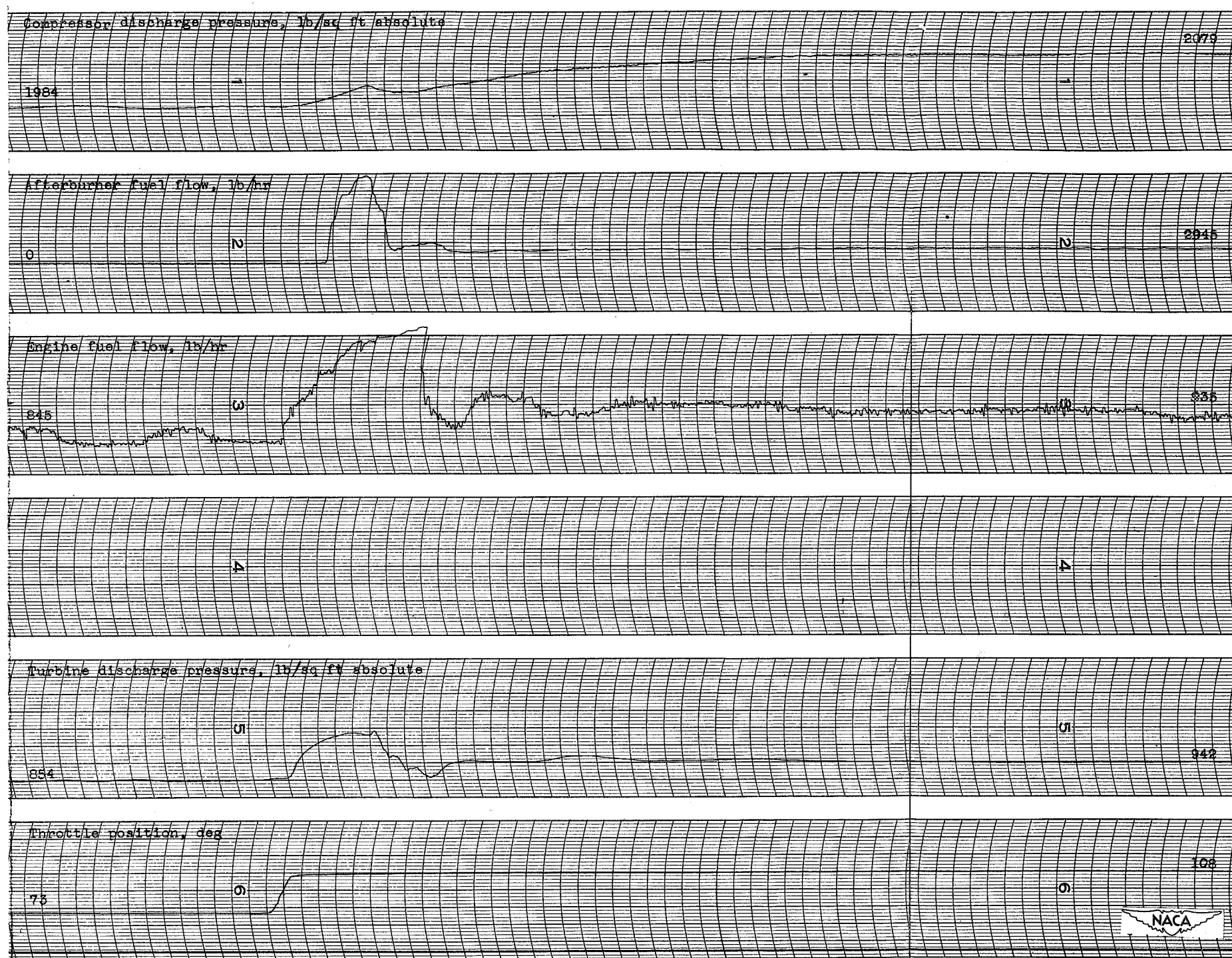


Figure 37. - Continued. Transient operation of automatically controlled engine with afterburner Throttle position, 73° to 108° ; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

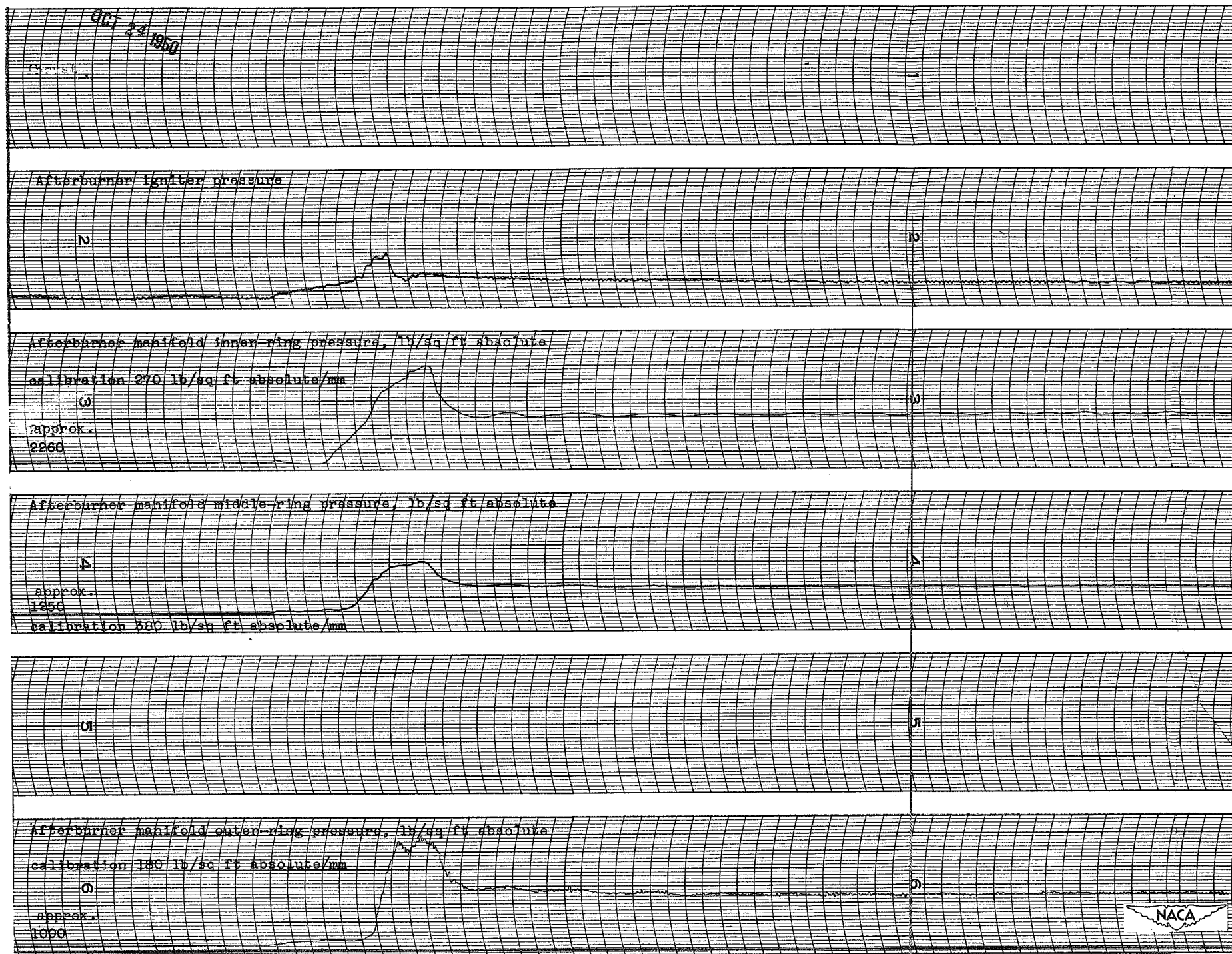


Figure 37. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 73° to 108° ; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

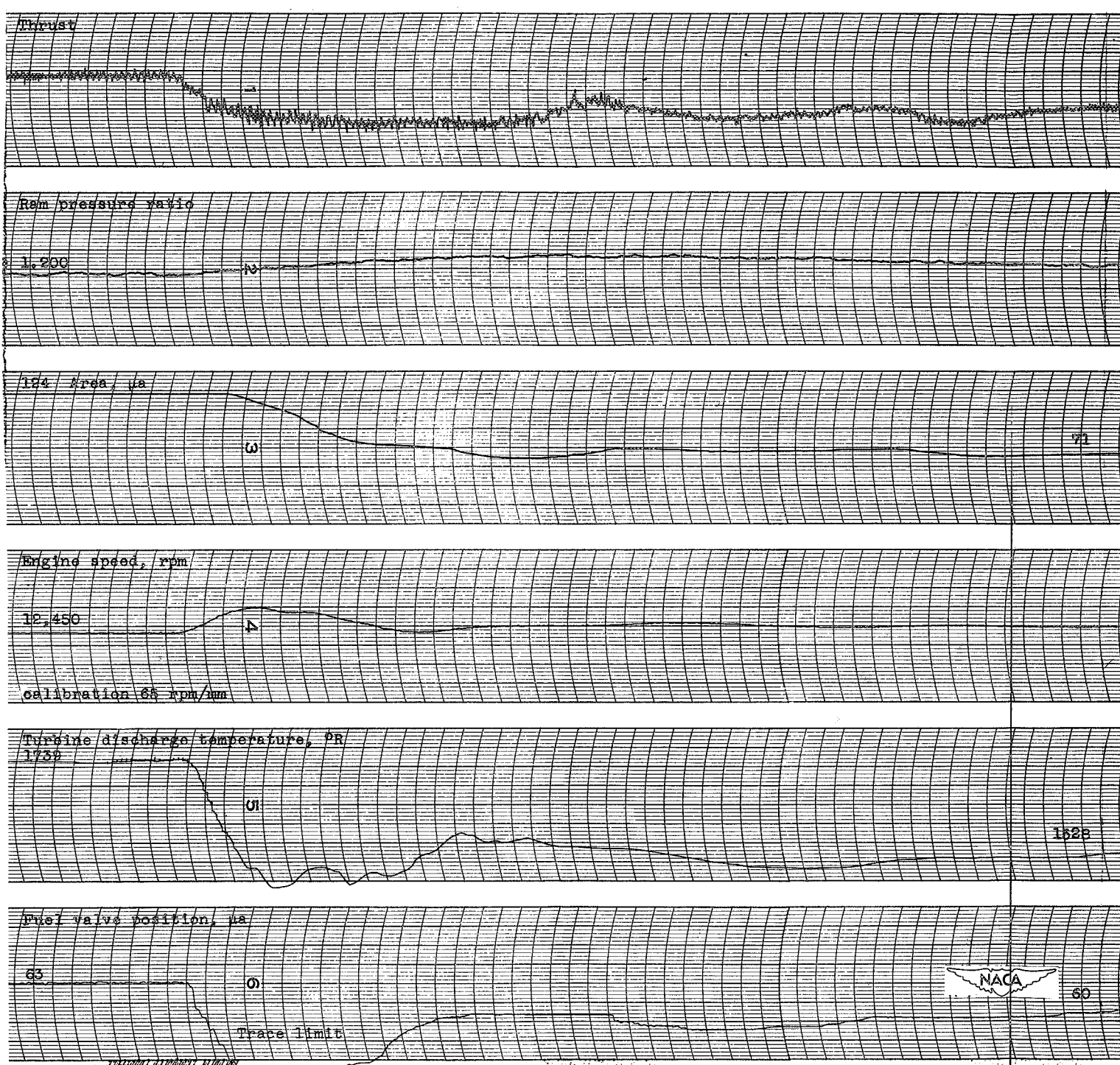


Figure 38. - Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 73° ; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

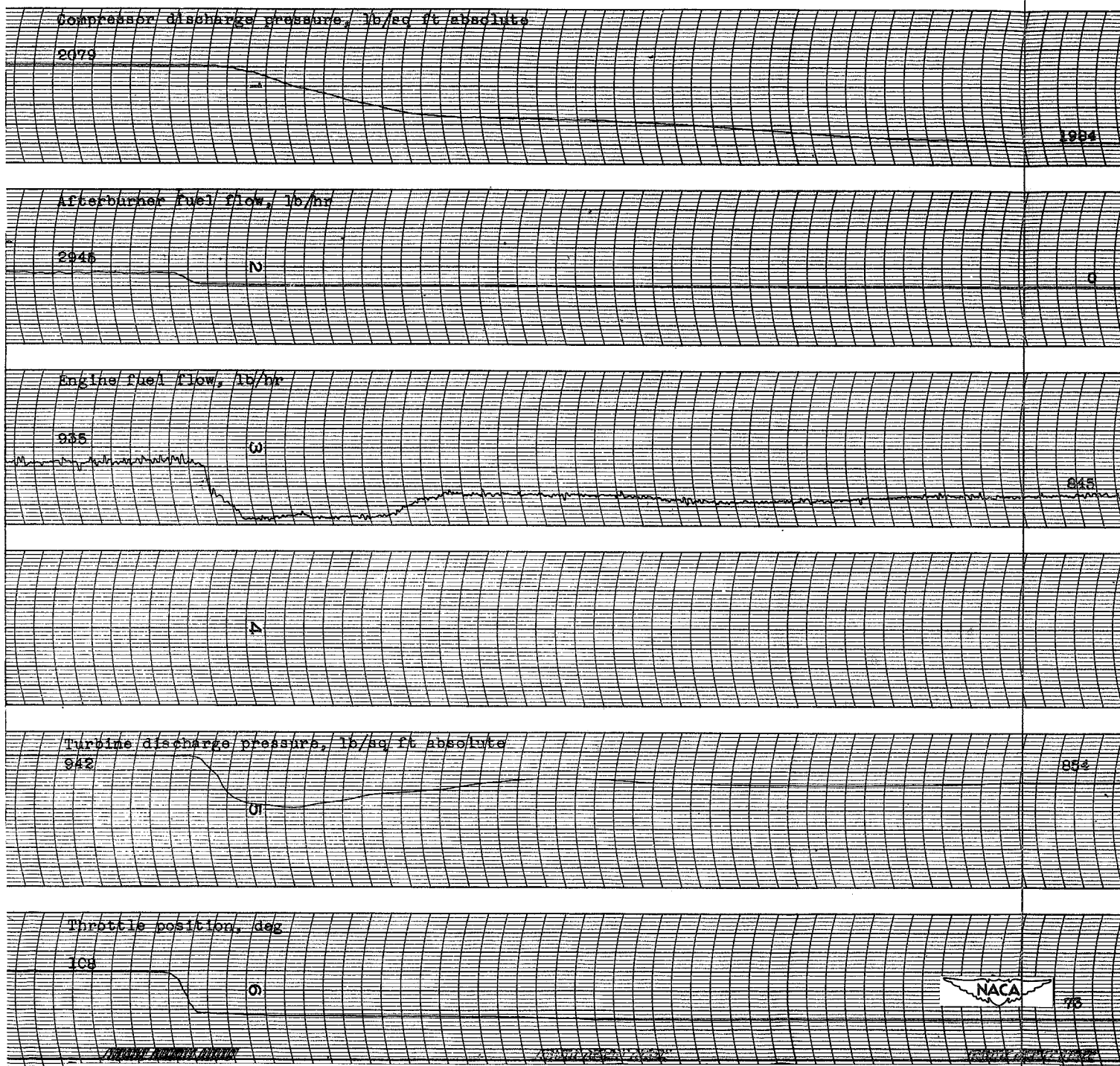


Figure 38. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 73° ; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

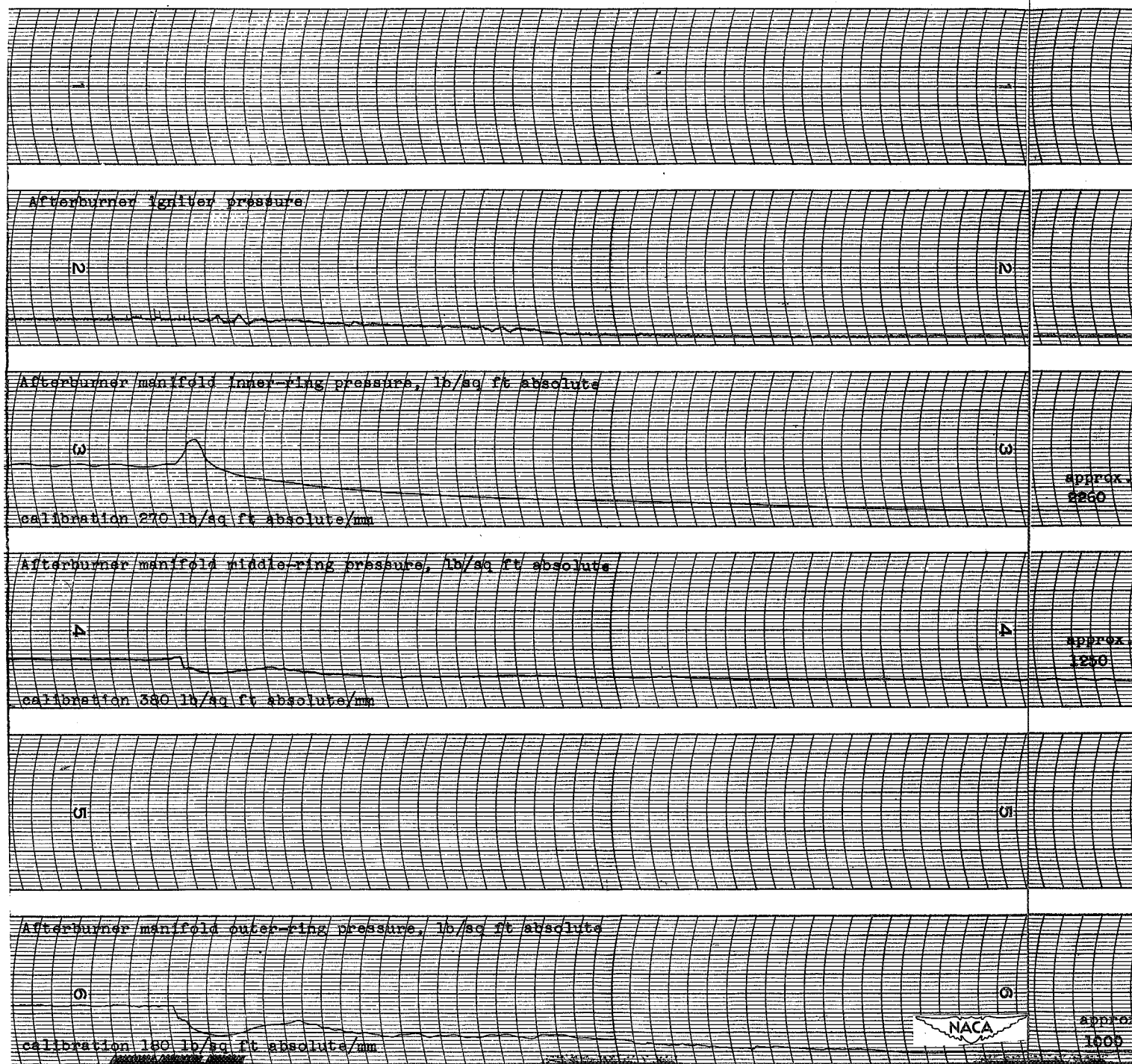


Figure 38. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 73°; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

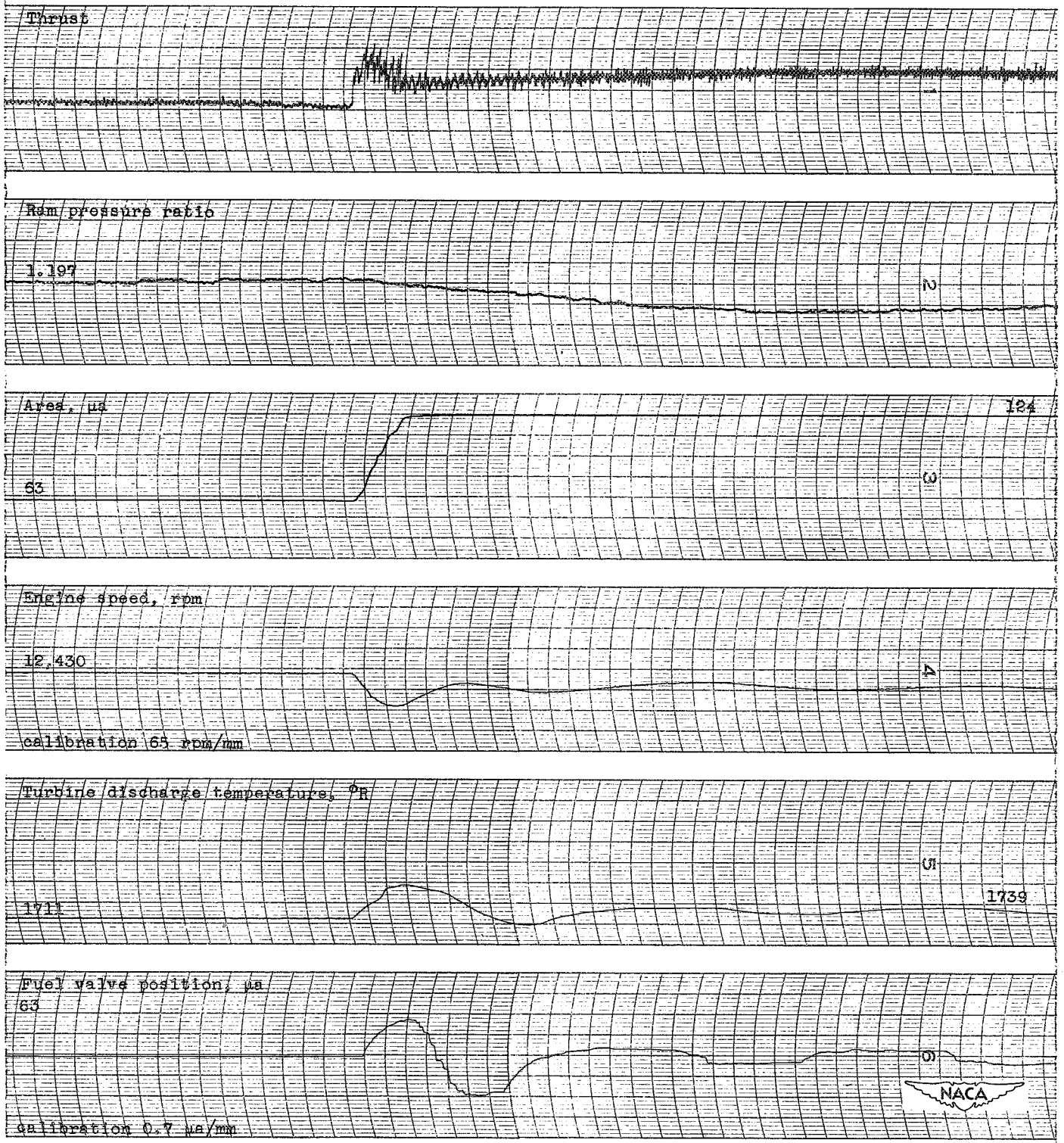


Figure 39. - Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 108° ; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

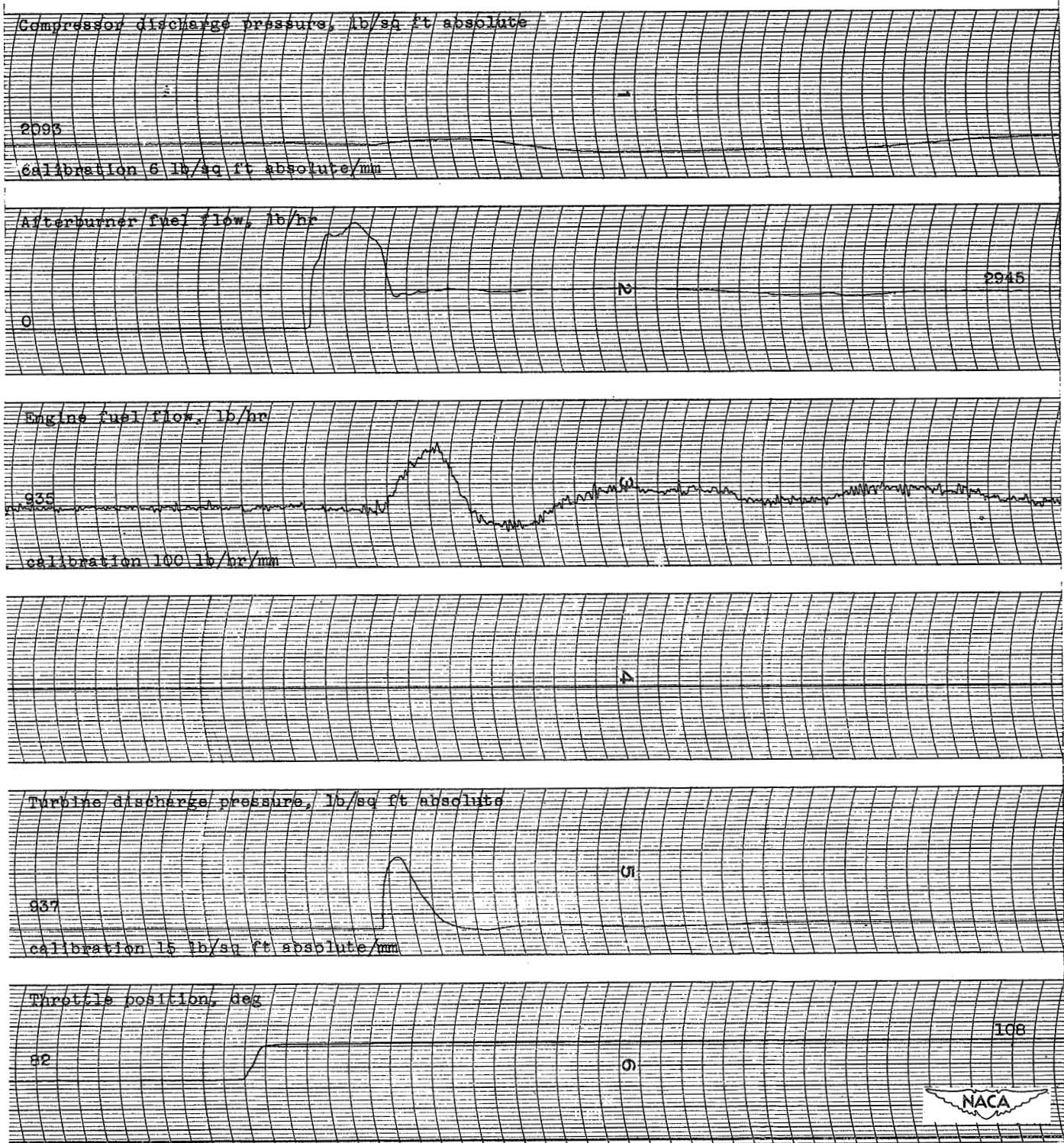


Figure 39. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 108°; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

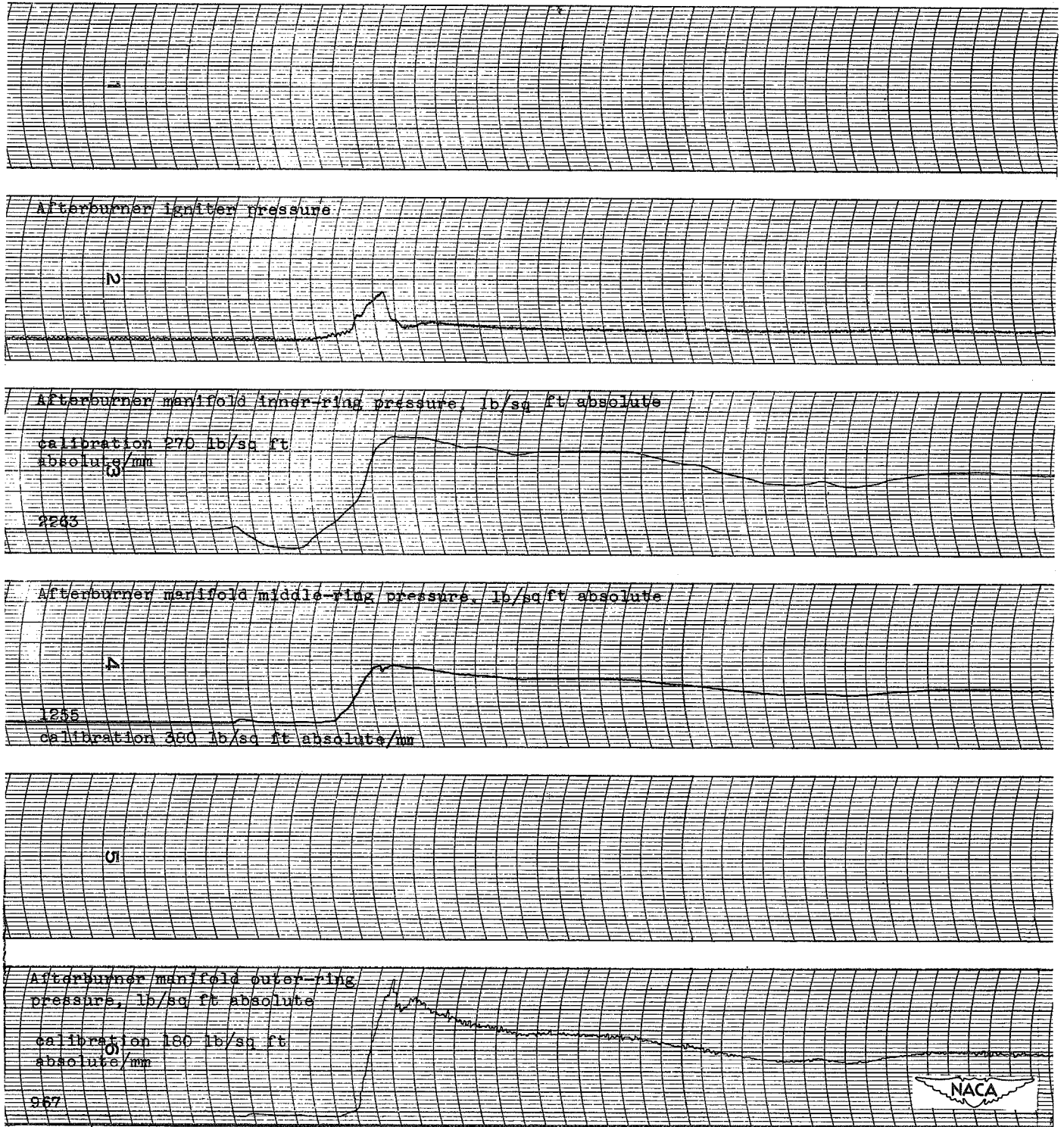


Figure 39. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 82° to 108°; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

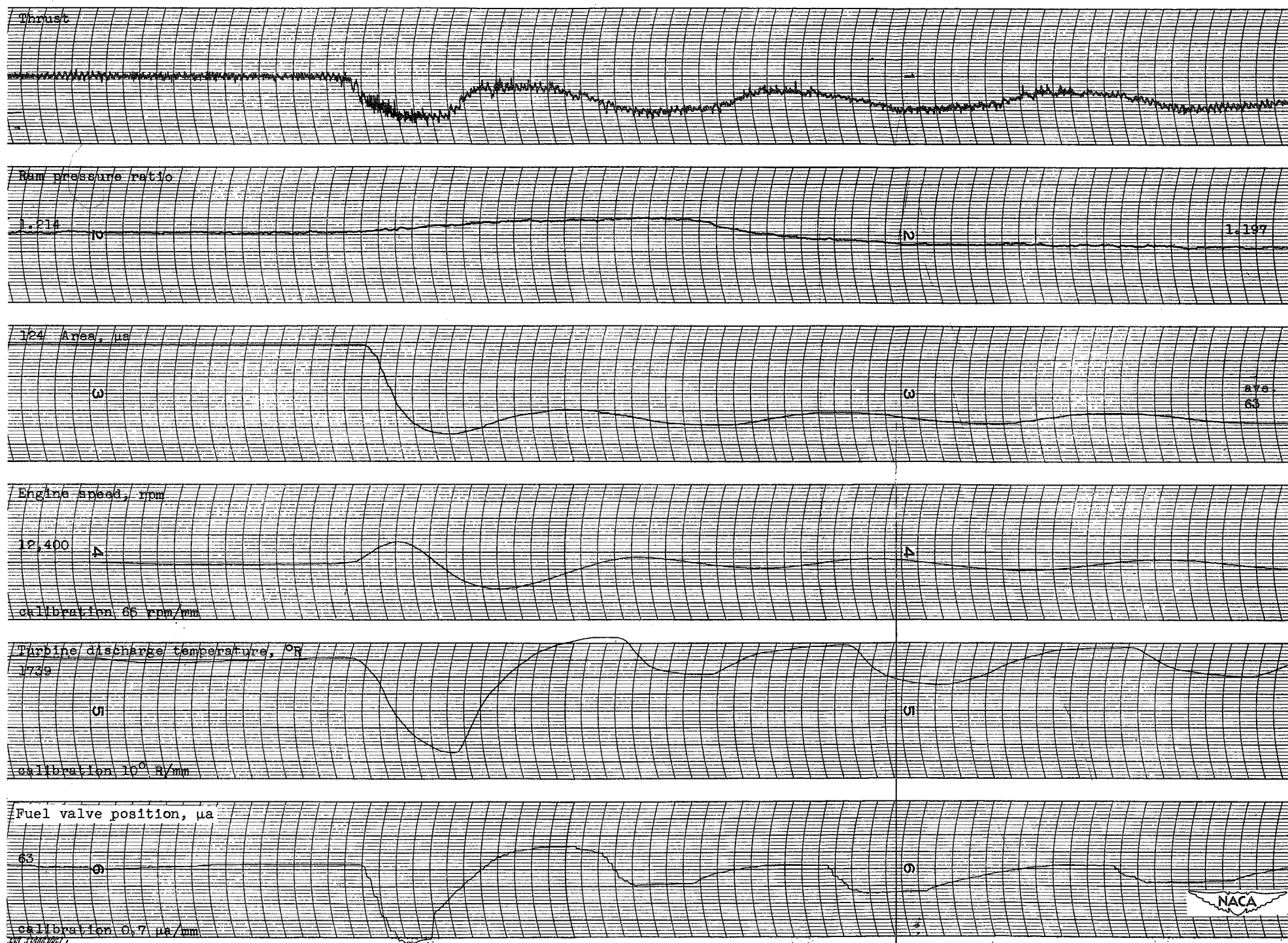


Figure 40. - Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 82° ; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

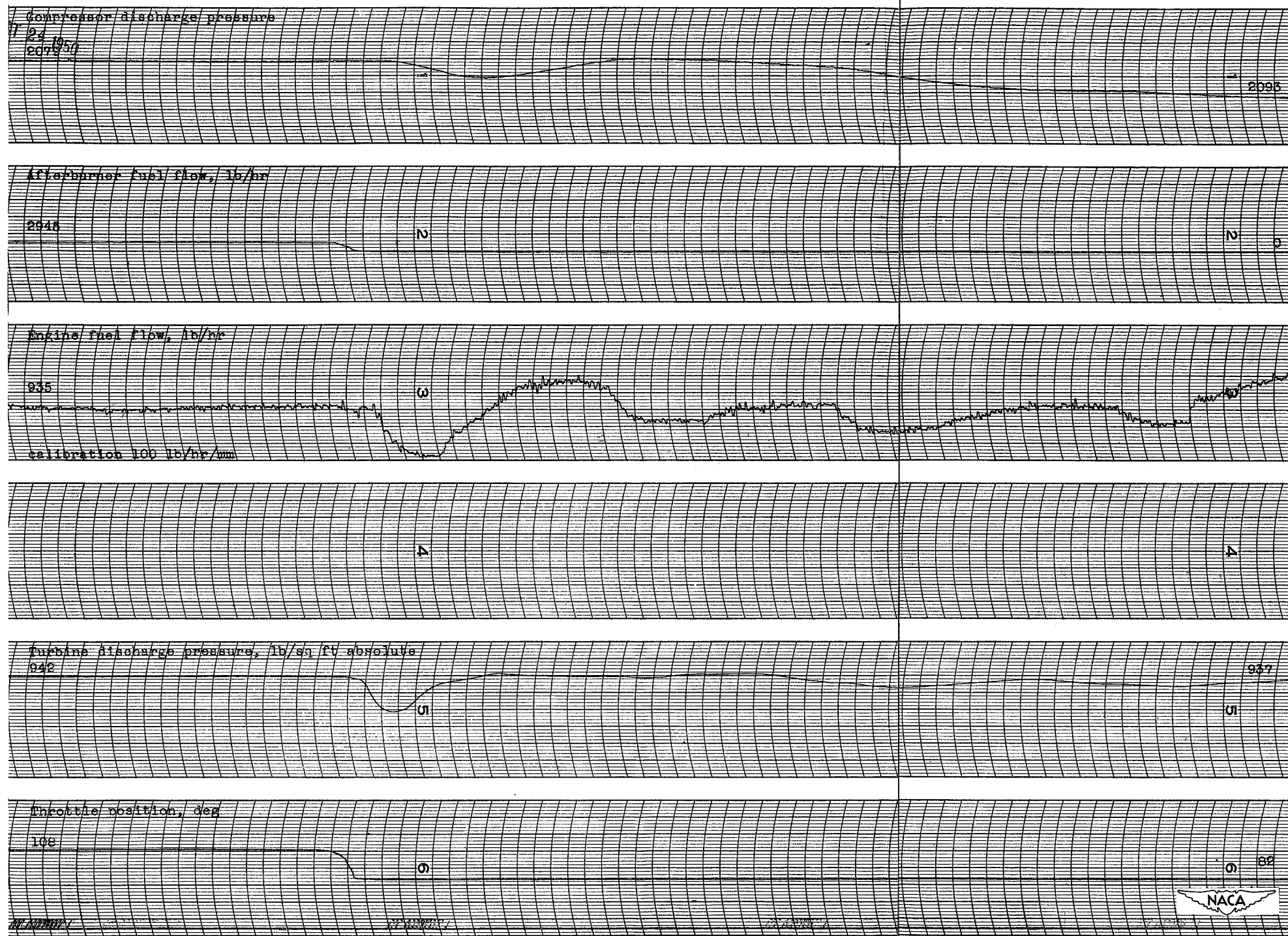


Figure 40. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 82° ; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

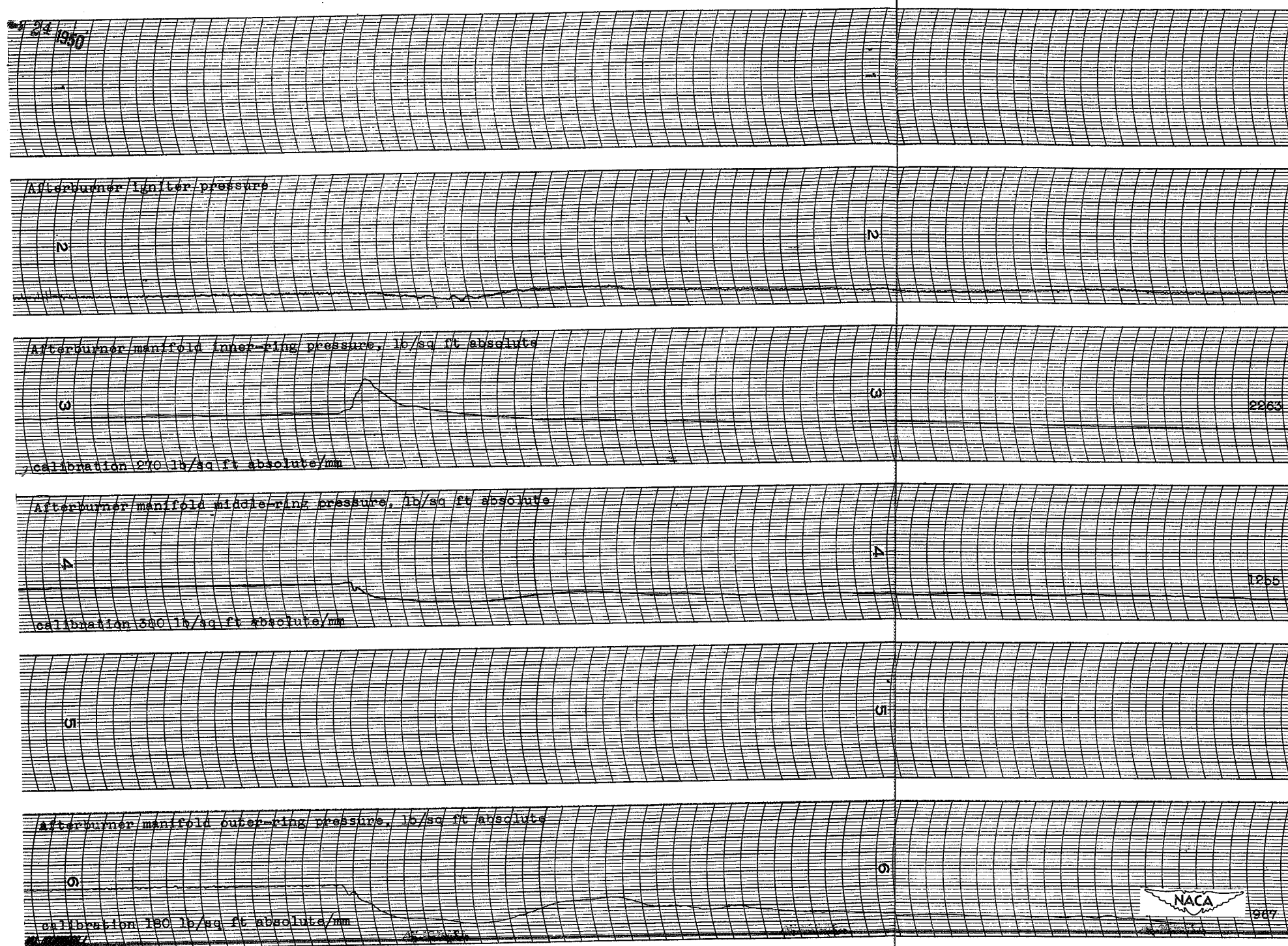


Figure 40. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 82° ; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure 18 pounds per square inch.

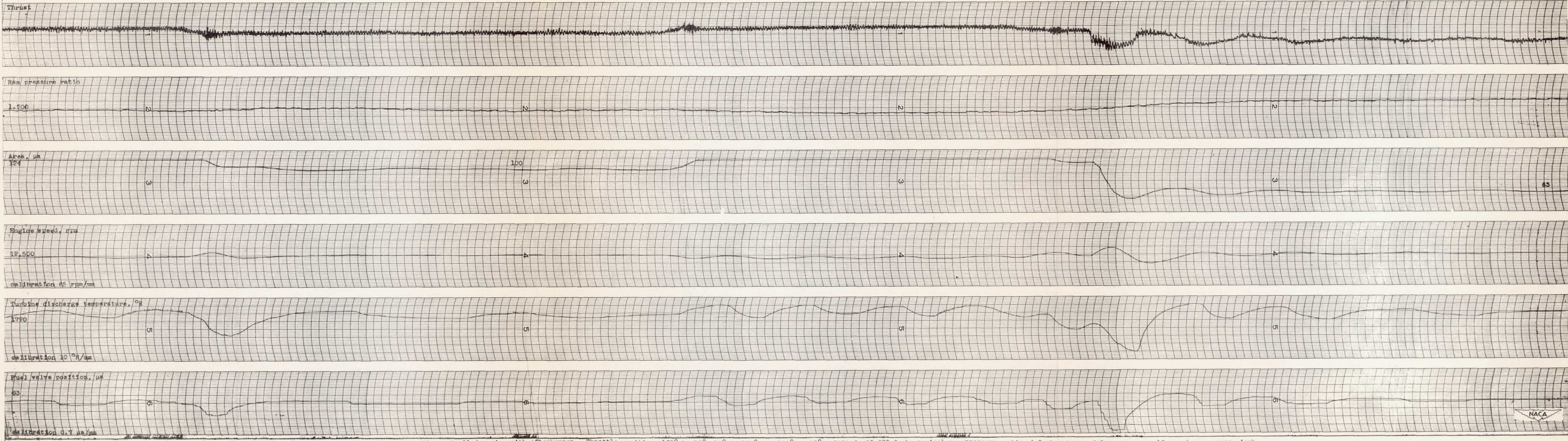


Figure 41. - Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 94°, 94° to 108° and 108° to 93°; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

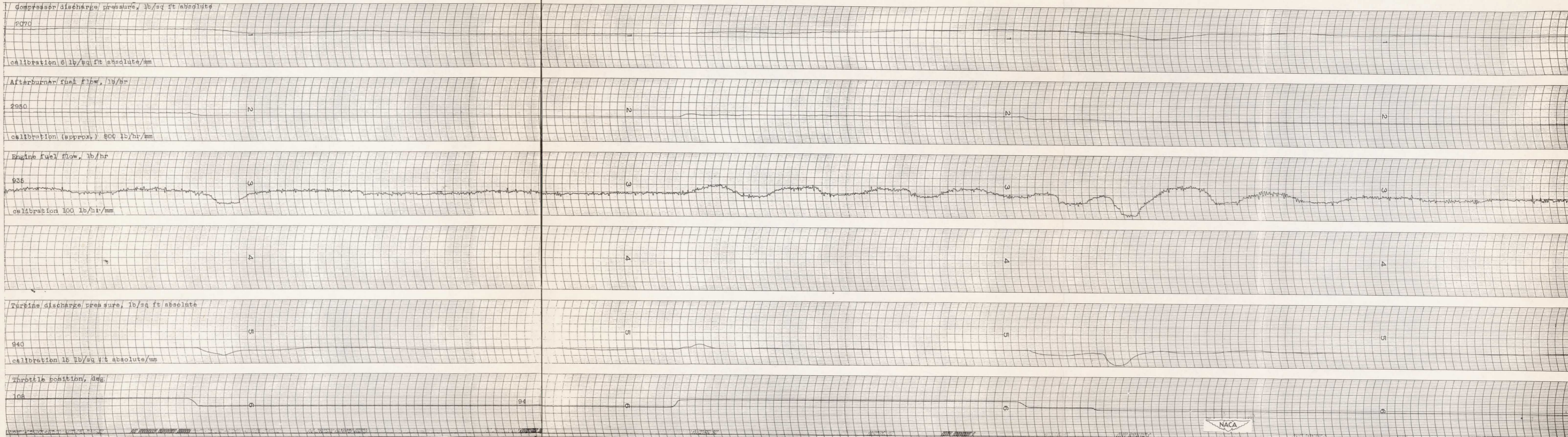


Figure 41. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 94°, 94° to 108° and 108° to 93°; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

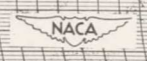




Figure 41. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 108° to 94°, 94° to 105° and 105° to 93°; altitude, 40,000 feet; nominal ram pressure ratio, 1.2; boost pump inlet pressure, 18 pounds per square inch.

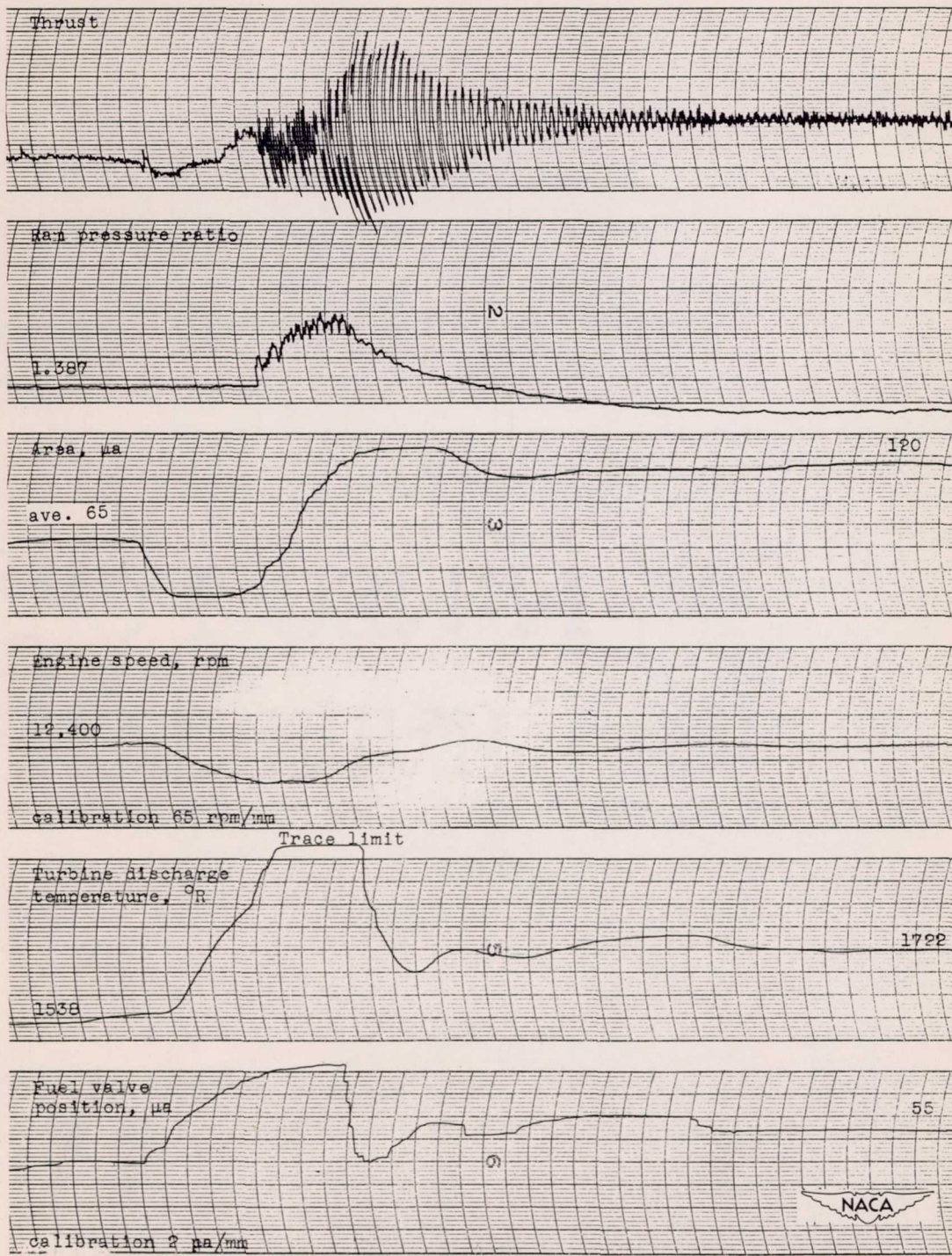


Figure 42. - Transient operation of automatically controlled engine with after-burner. Throttle position, 72° to 110° ; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

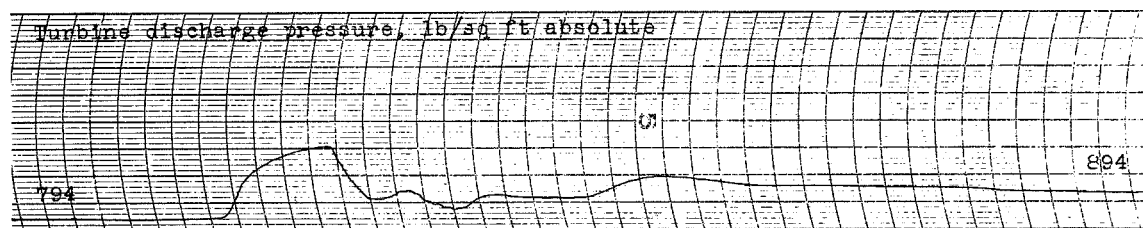
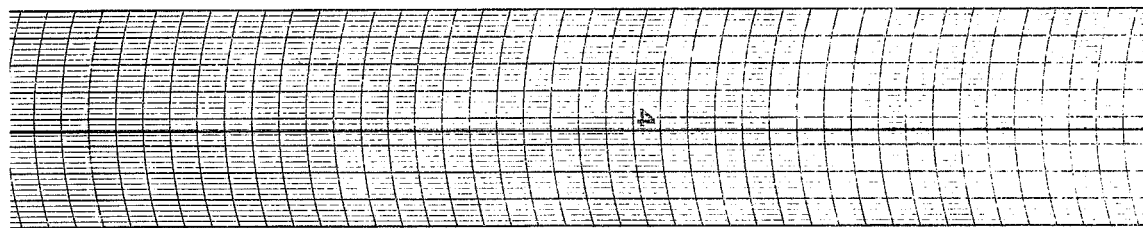
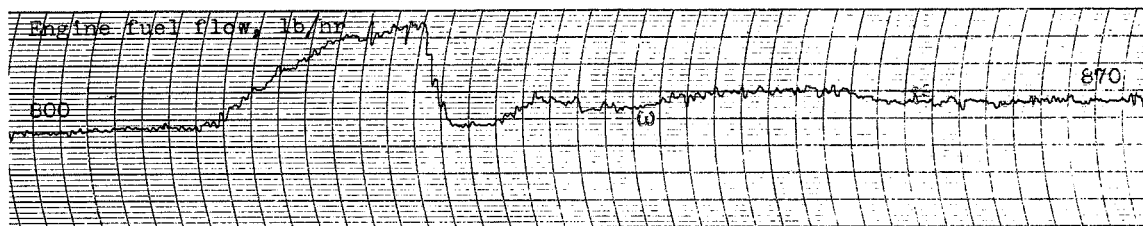
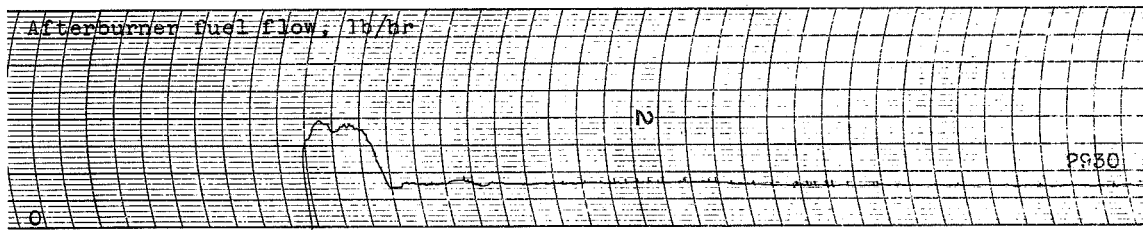
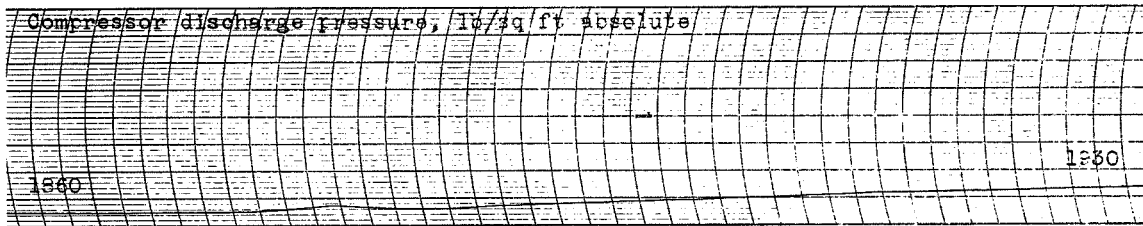


Figure 42. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 110°; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

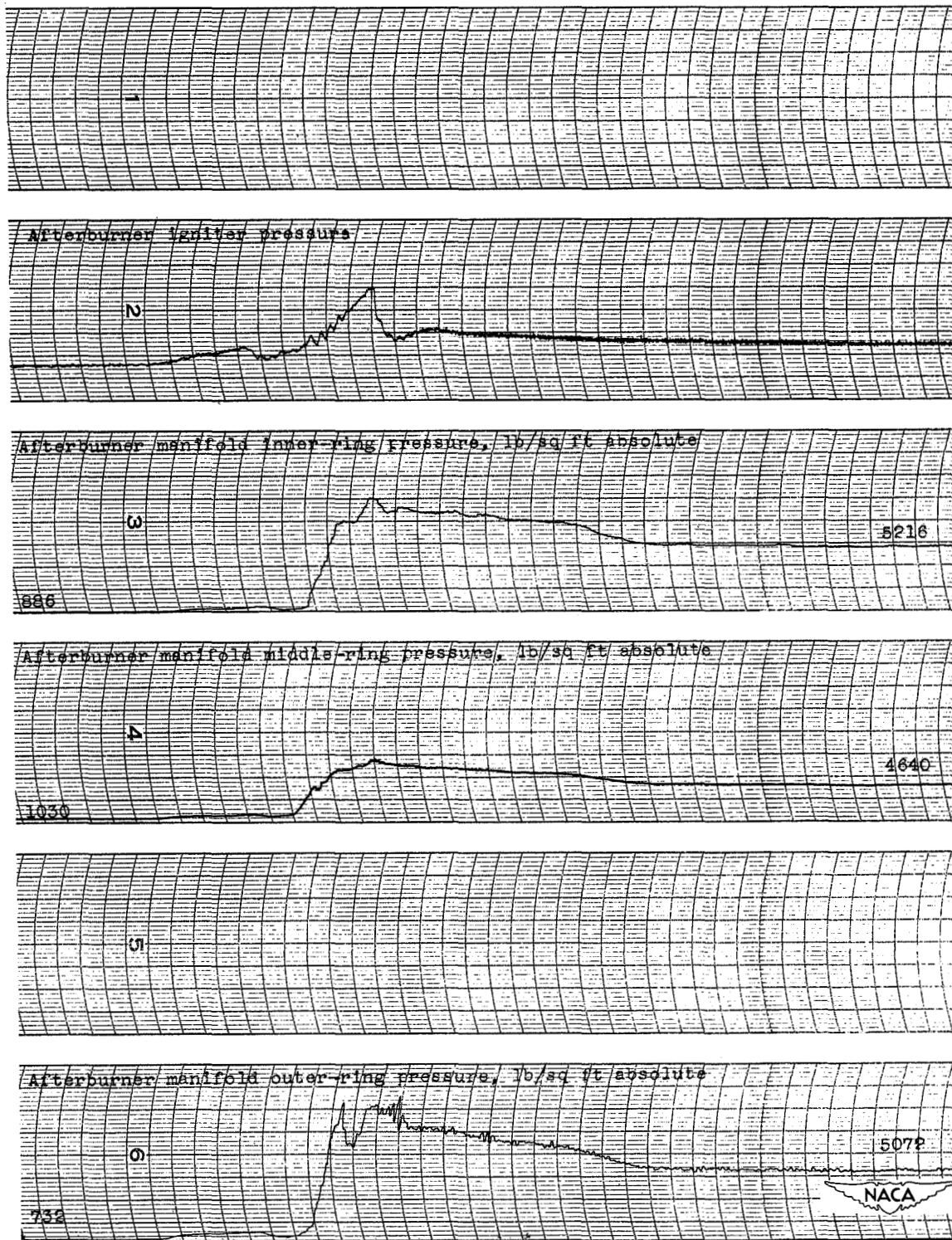


Figure 42. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 72° to 110°; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

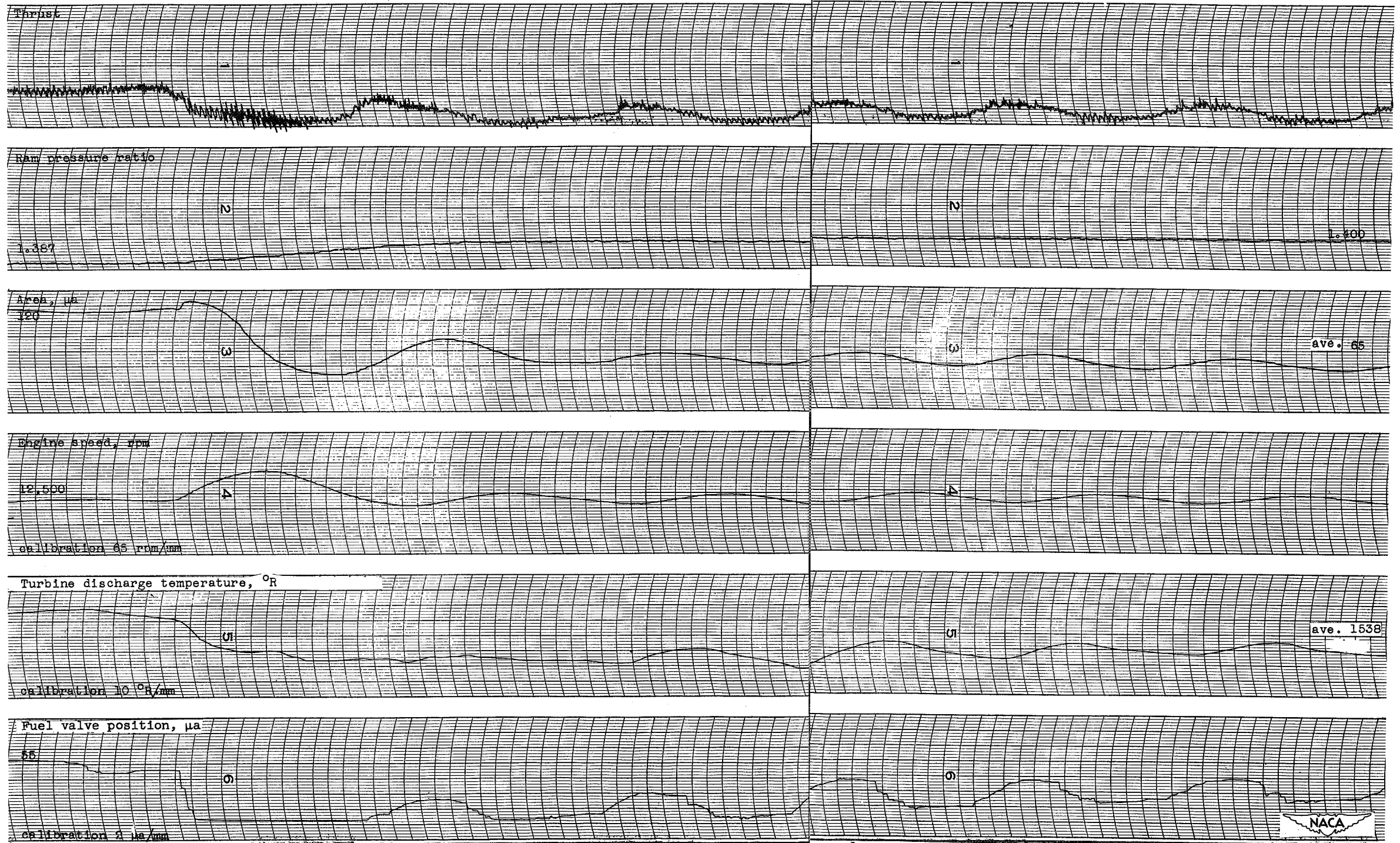


Figure 43. - Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 72° ; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

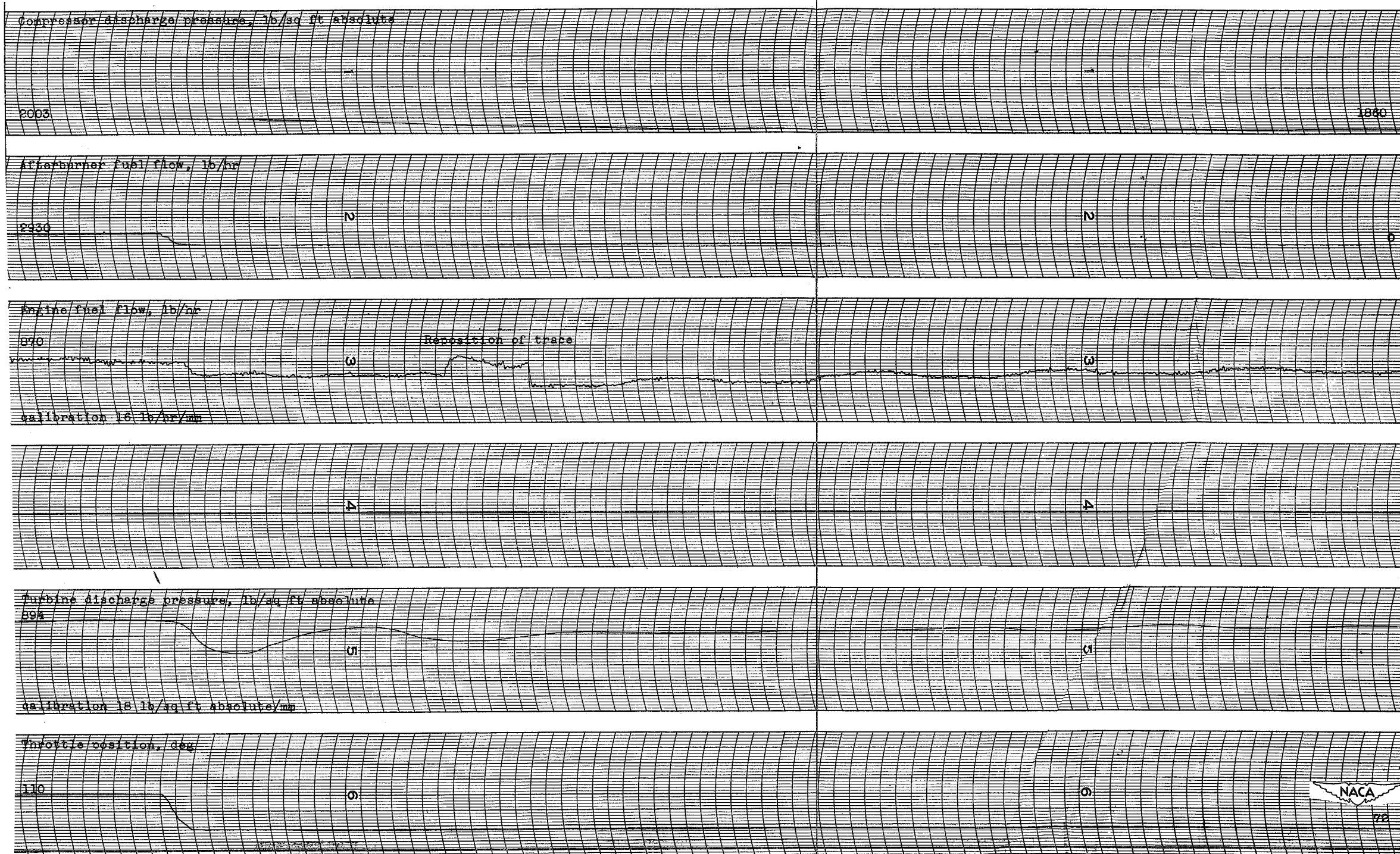


Figure 43. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 72°; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

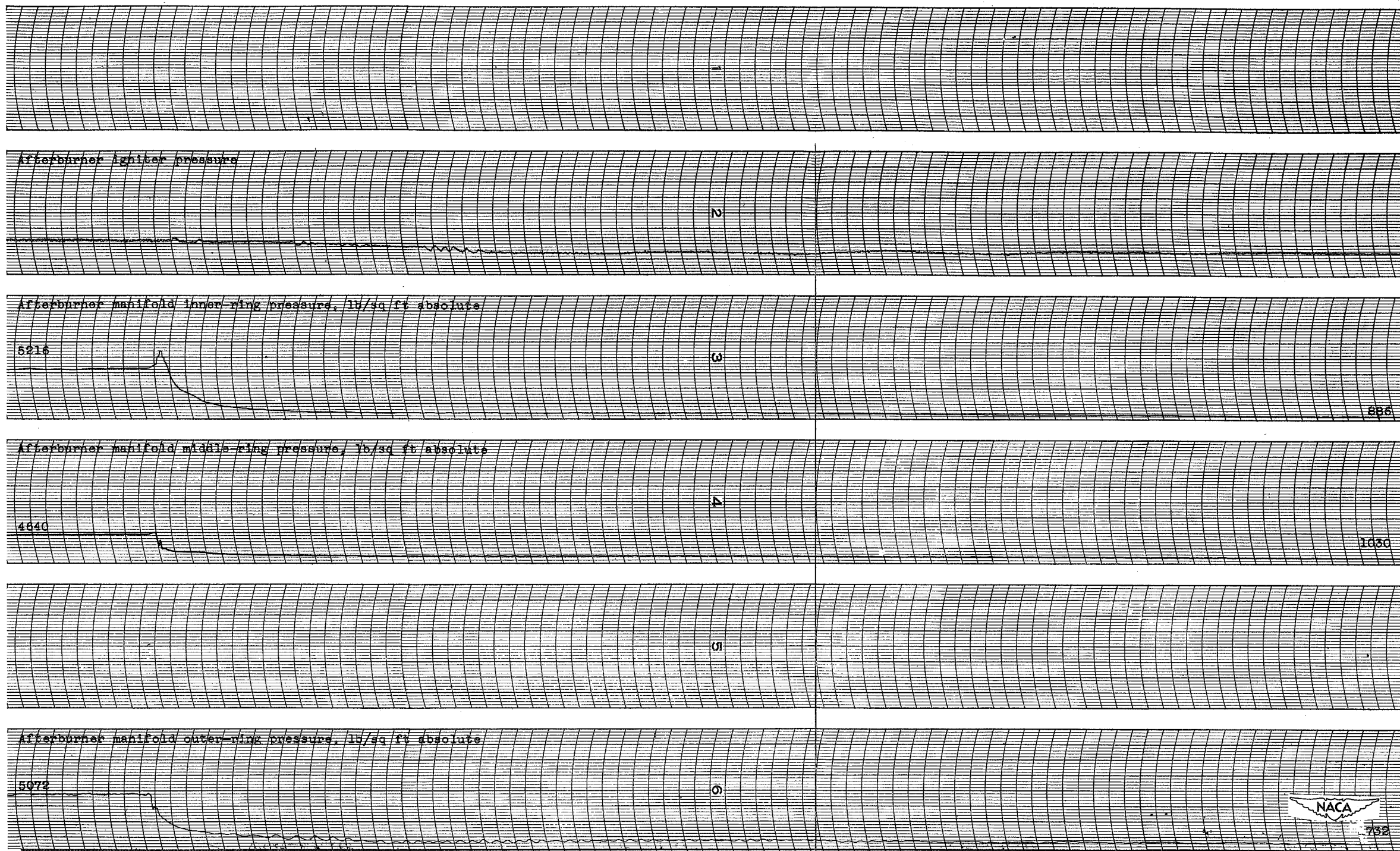


Figure 43. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 72°; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 16 pounds per square inch.

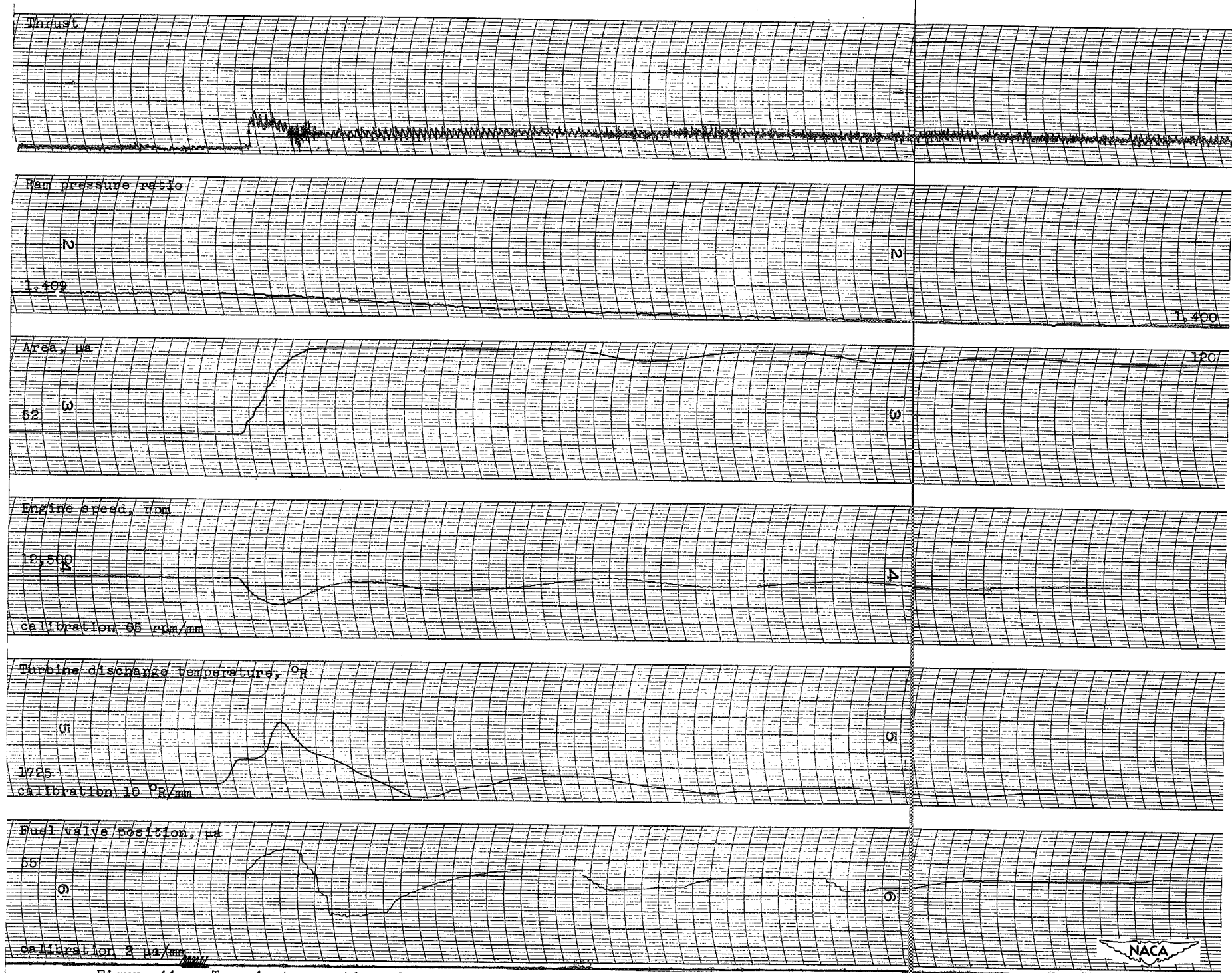


Figure 44. - Transient operation of automatically controlled engine with afterburner. Throttle position, 83° to 110° ; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

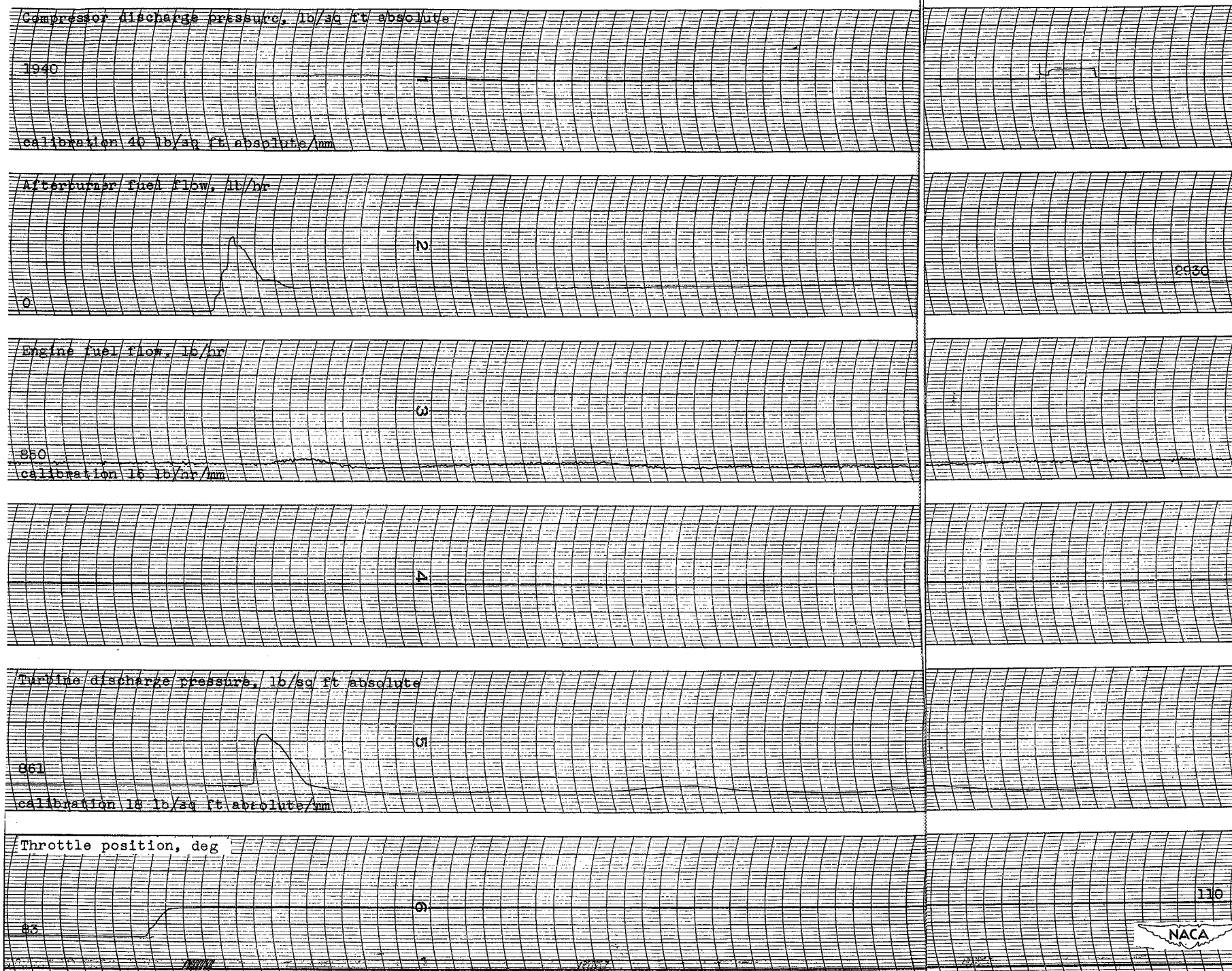


Figure 44. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 83° to 110°; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

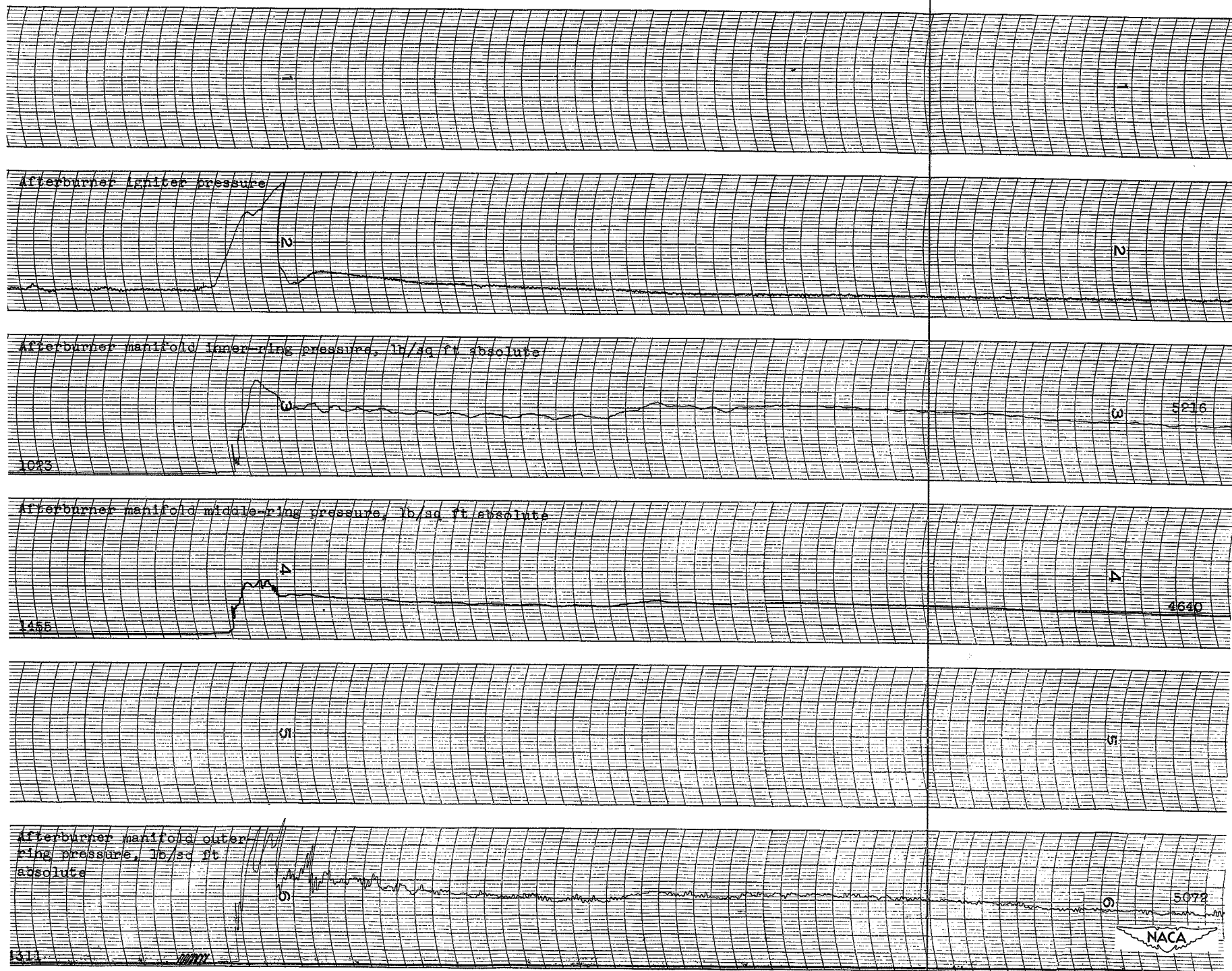


Figure 44. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 83° to 110° ; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

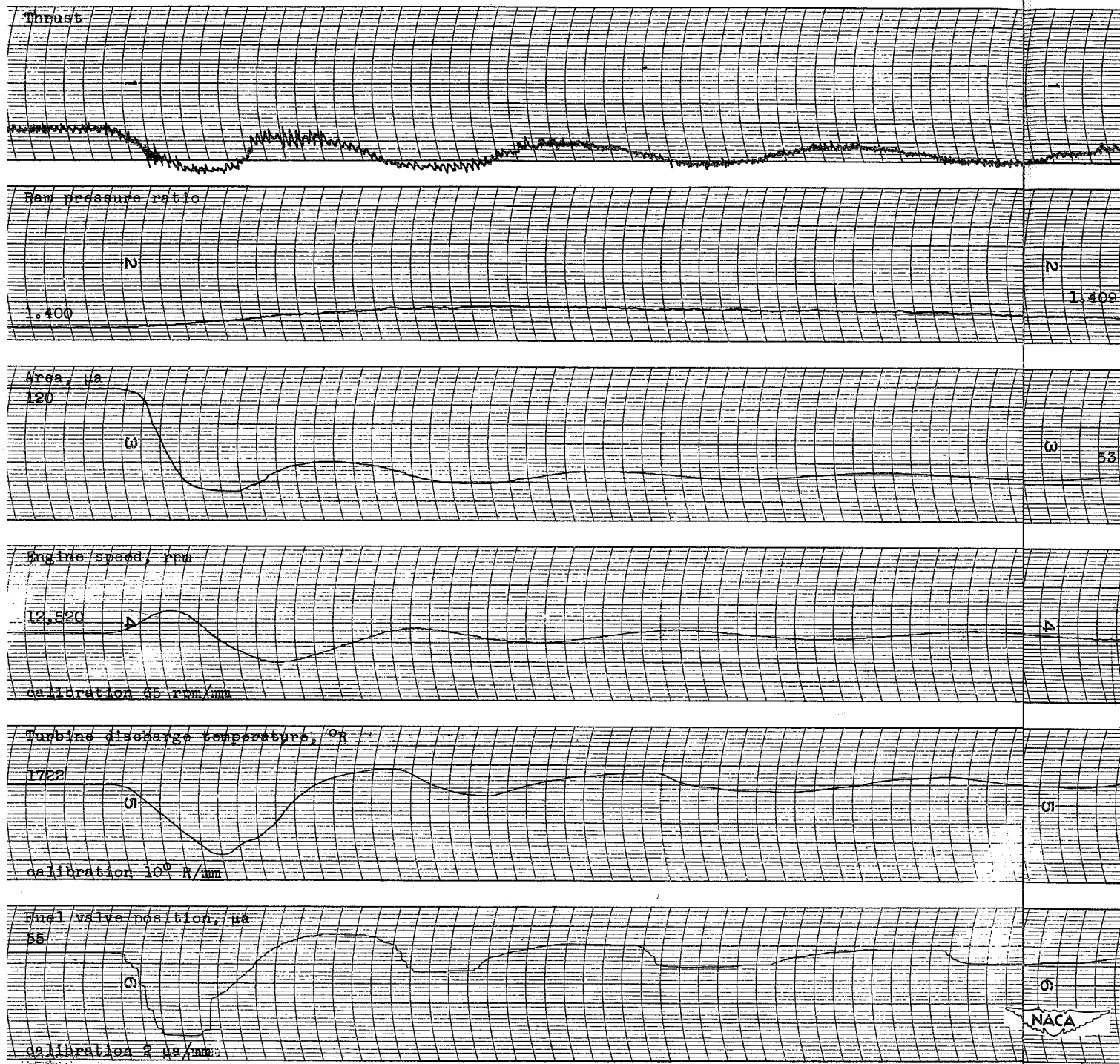


Figure 45. - Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 83° ; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

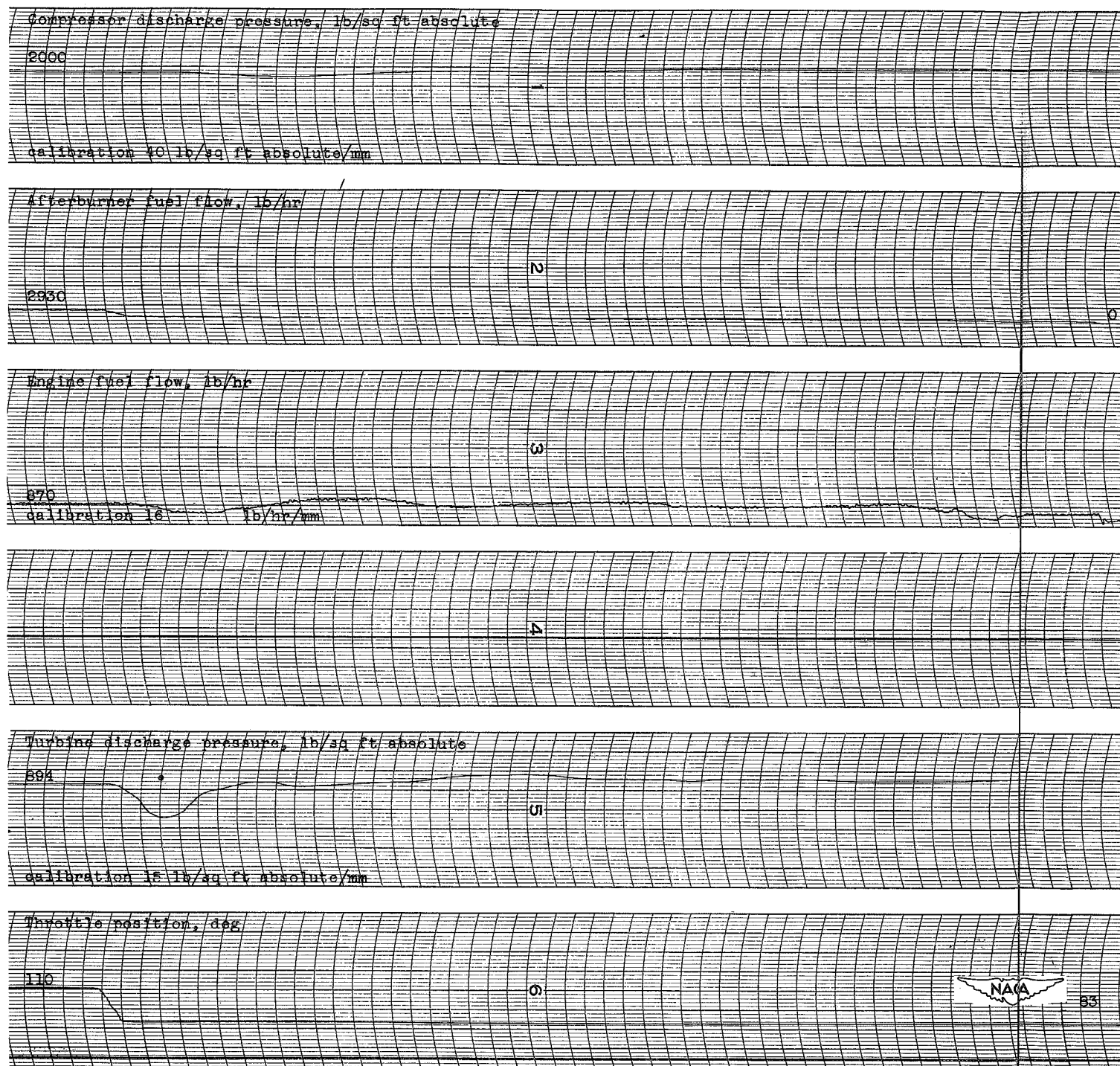


Figure 45. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 83° ; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

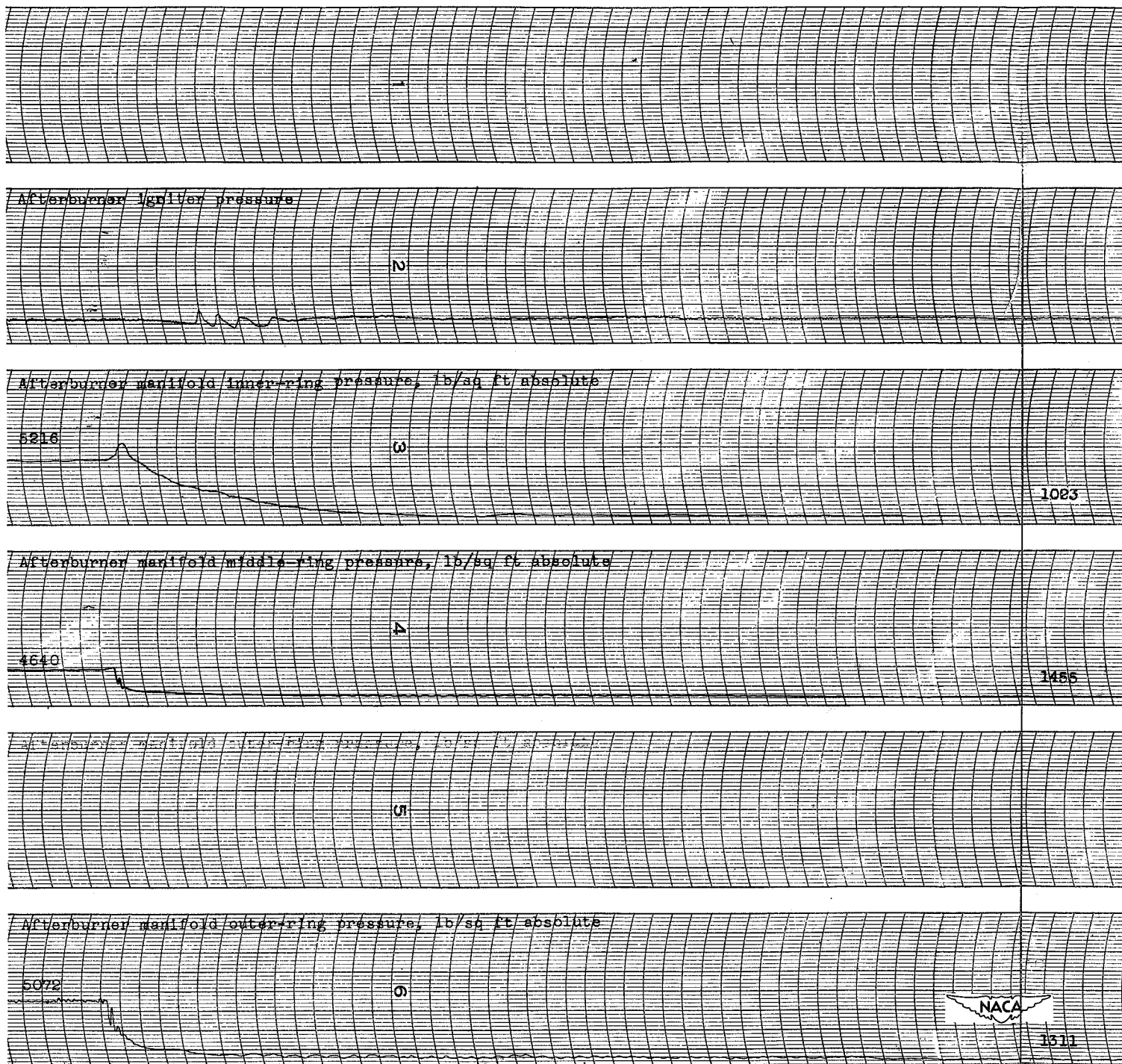


Figure 45. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 83° ; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

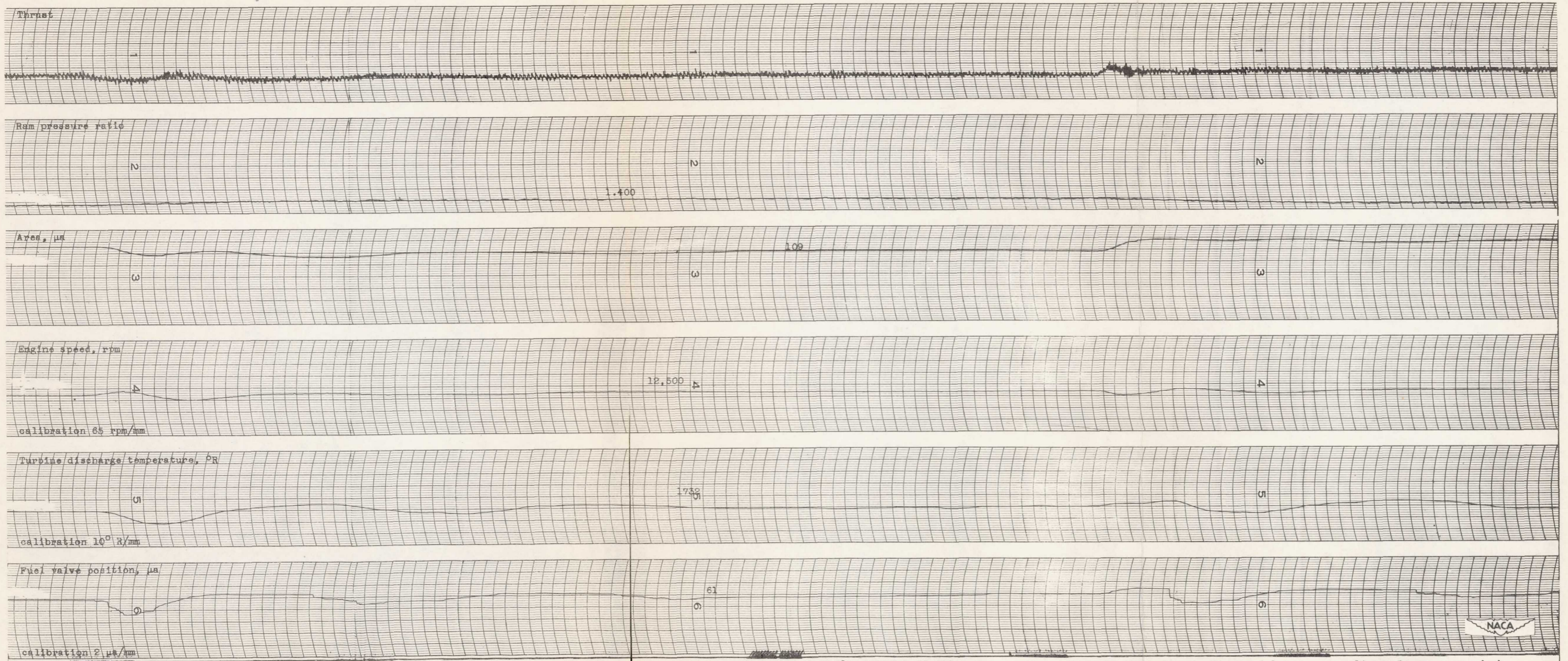


Figure 46. - Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 104° and 104° to 110° ; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

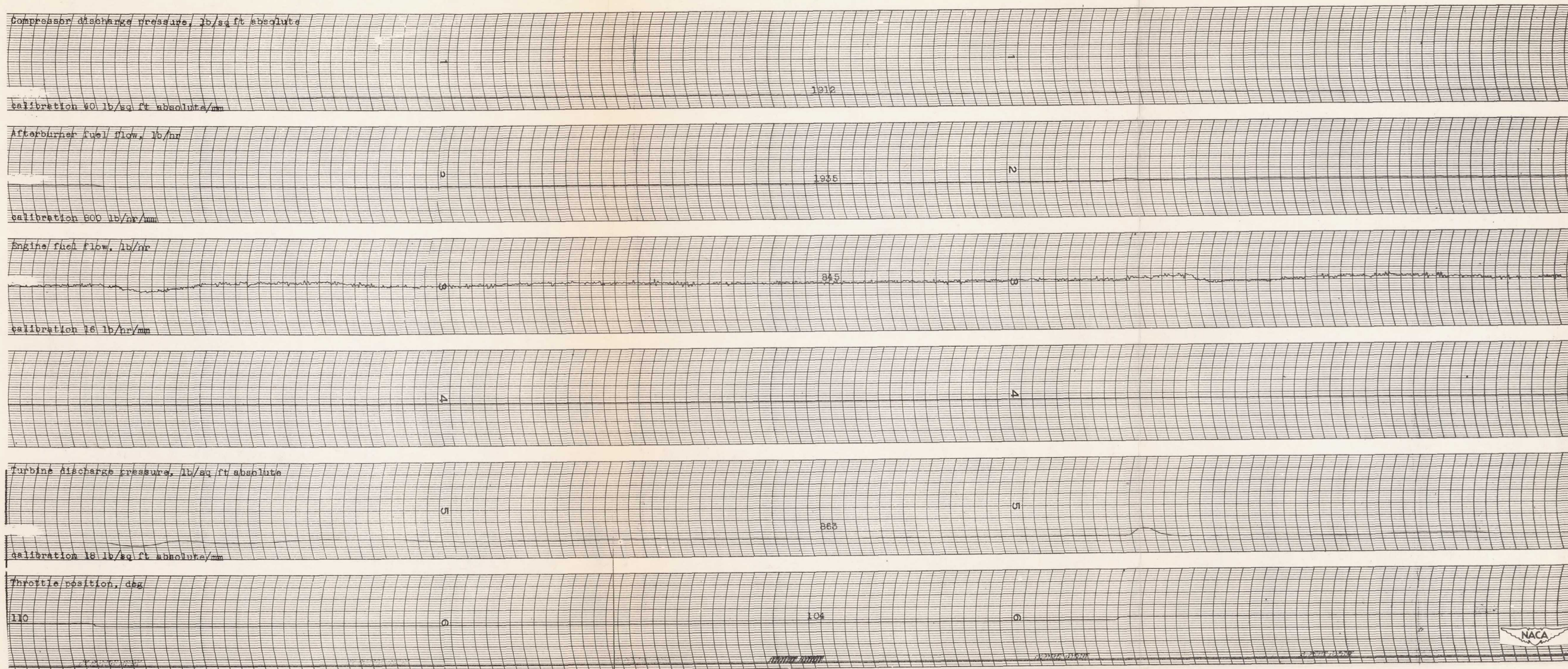


Figure 46. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 104° and 104° to 110°; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

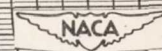




Figure 46. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 104° and 104° to 110°; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

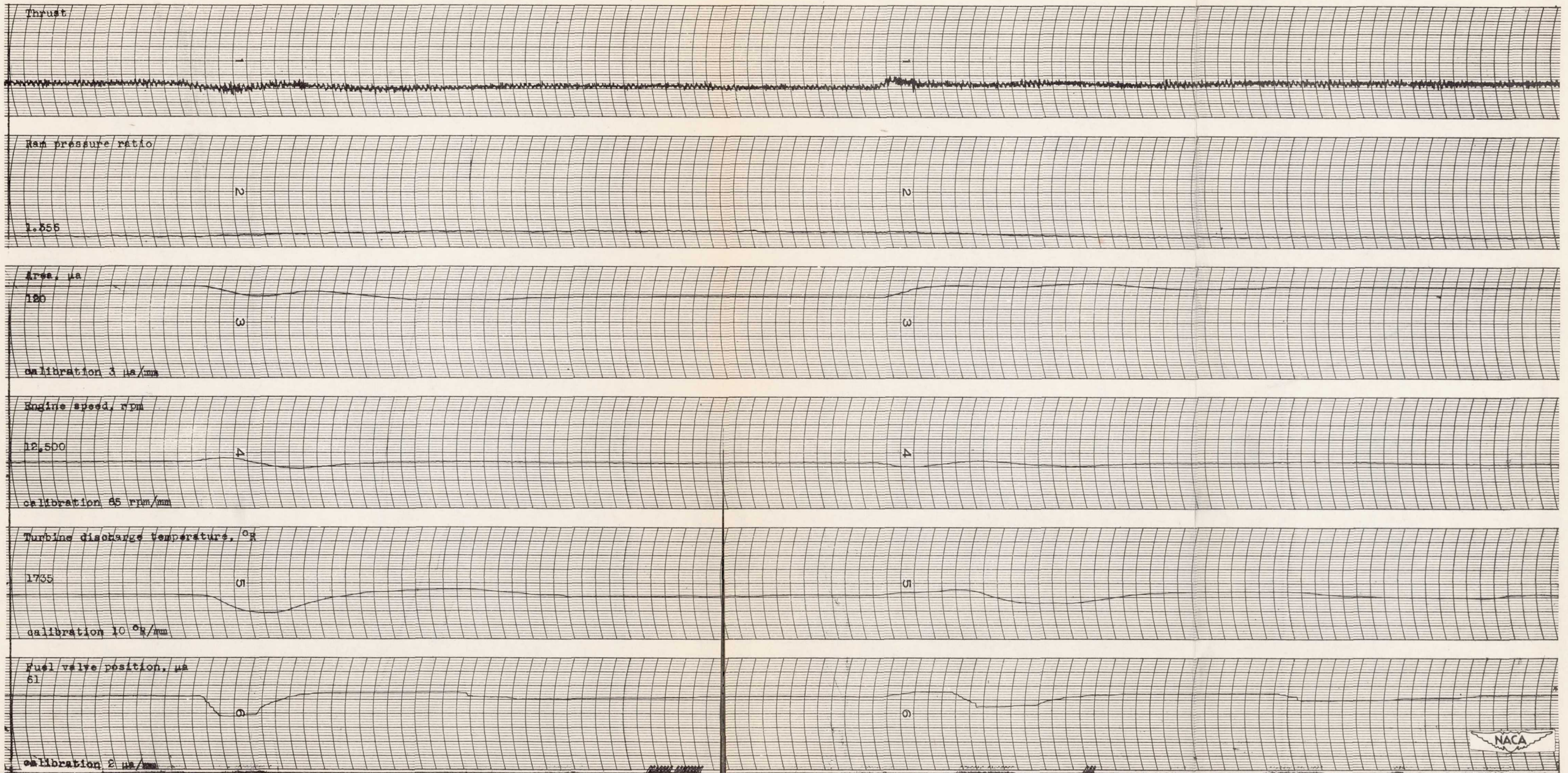


Figure 47. - Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 100° and 100° to 110° ; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

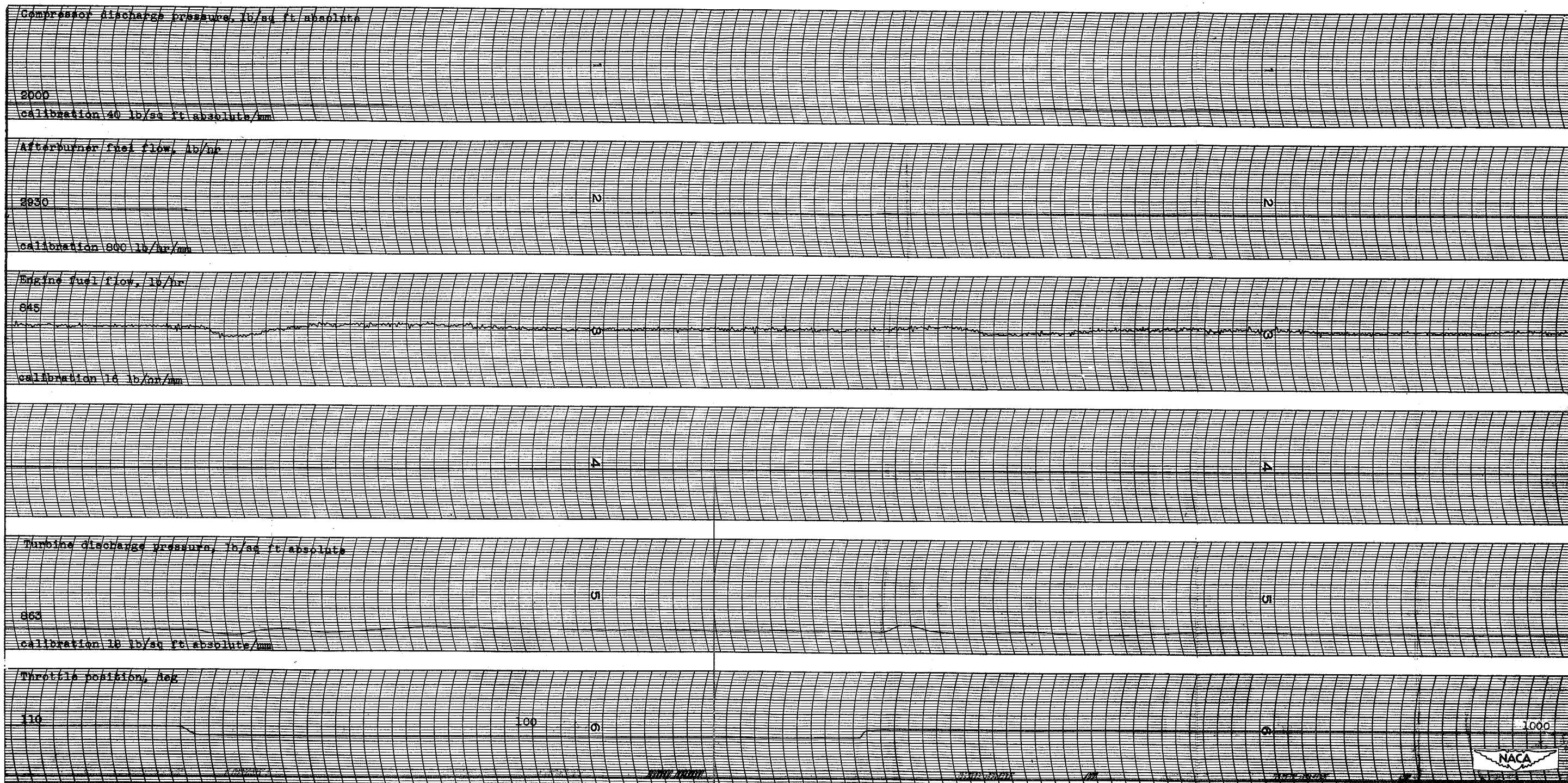


Figure 47. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 100° and 100° to 110°; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

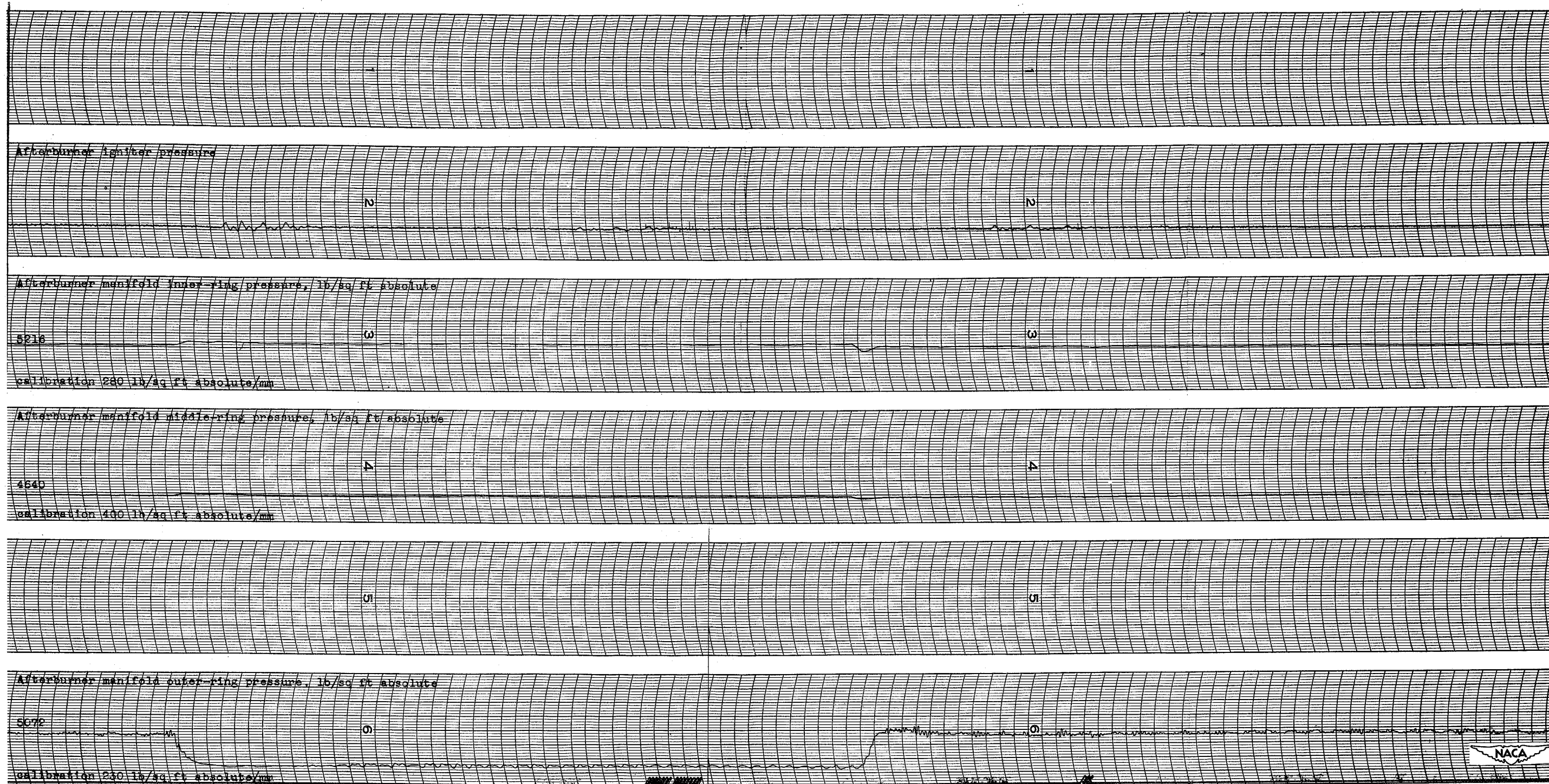


Figure 47. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 110° to 100° and 100° to 110°; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

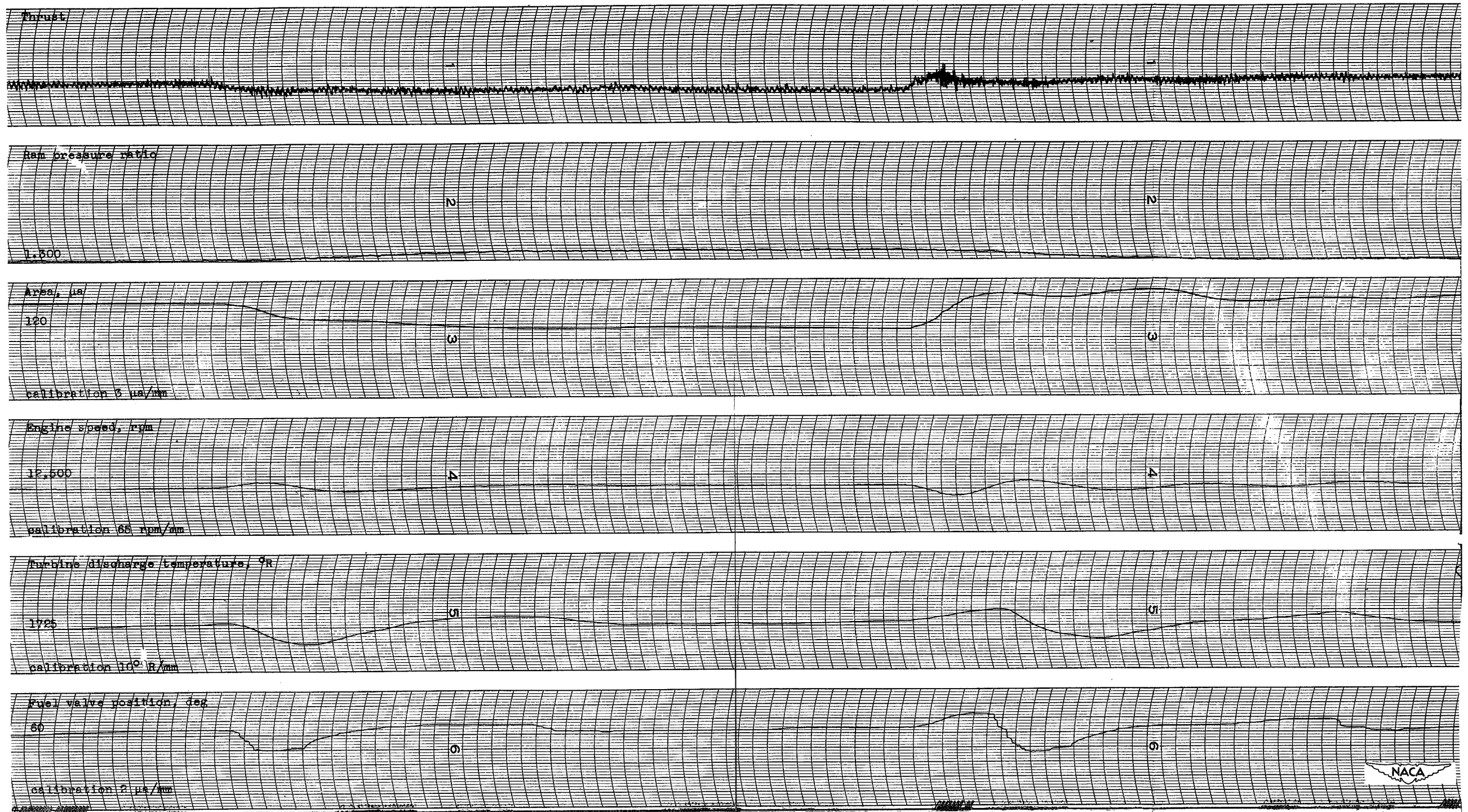


Figure 48. - Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 94° and 94° to 109°; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

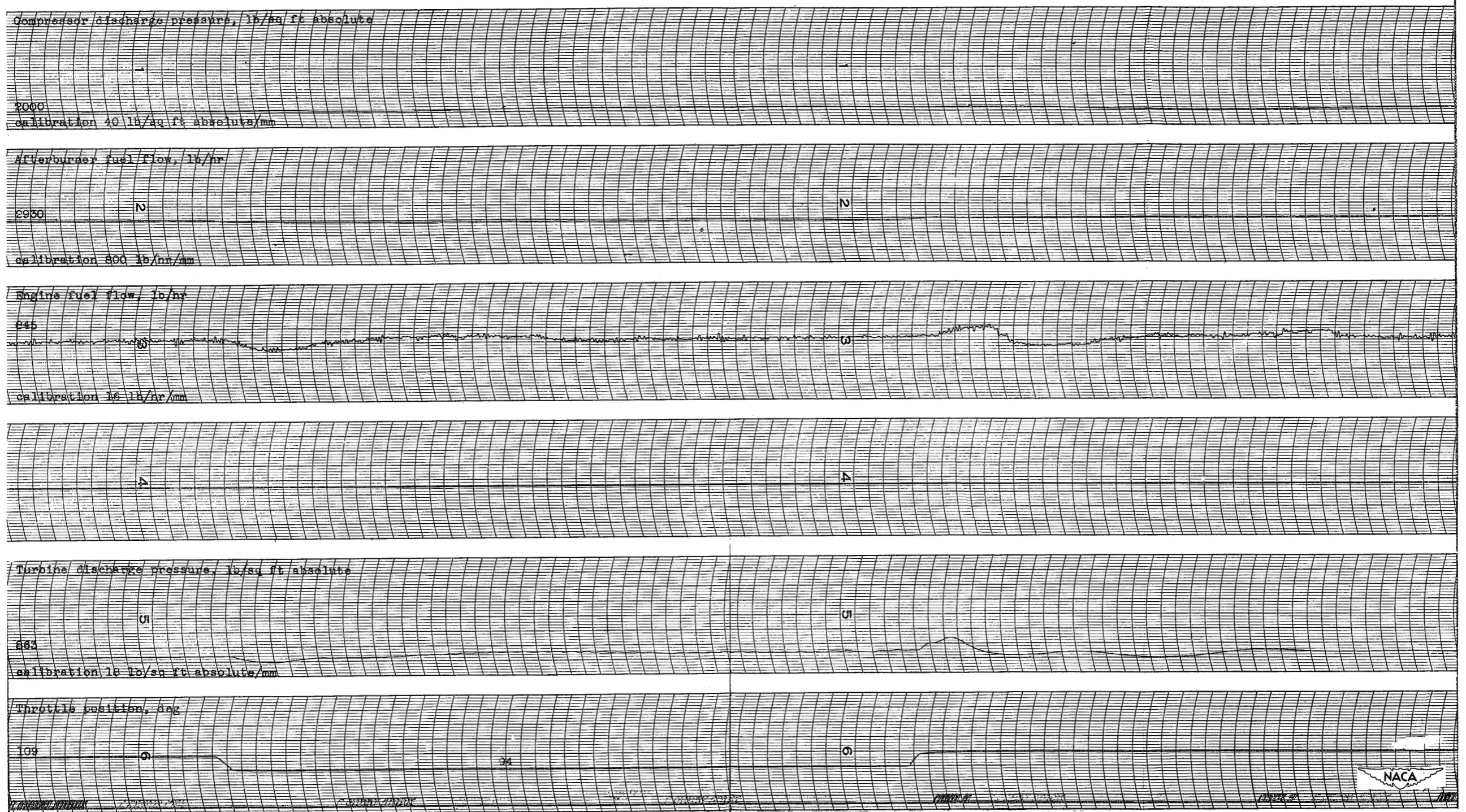


Figure 48. - Continued. Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 94° and 94° to 109°; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.

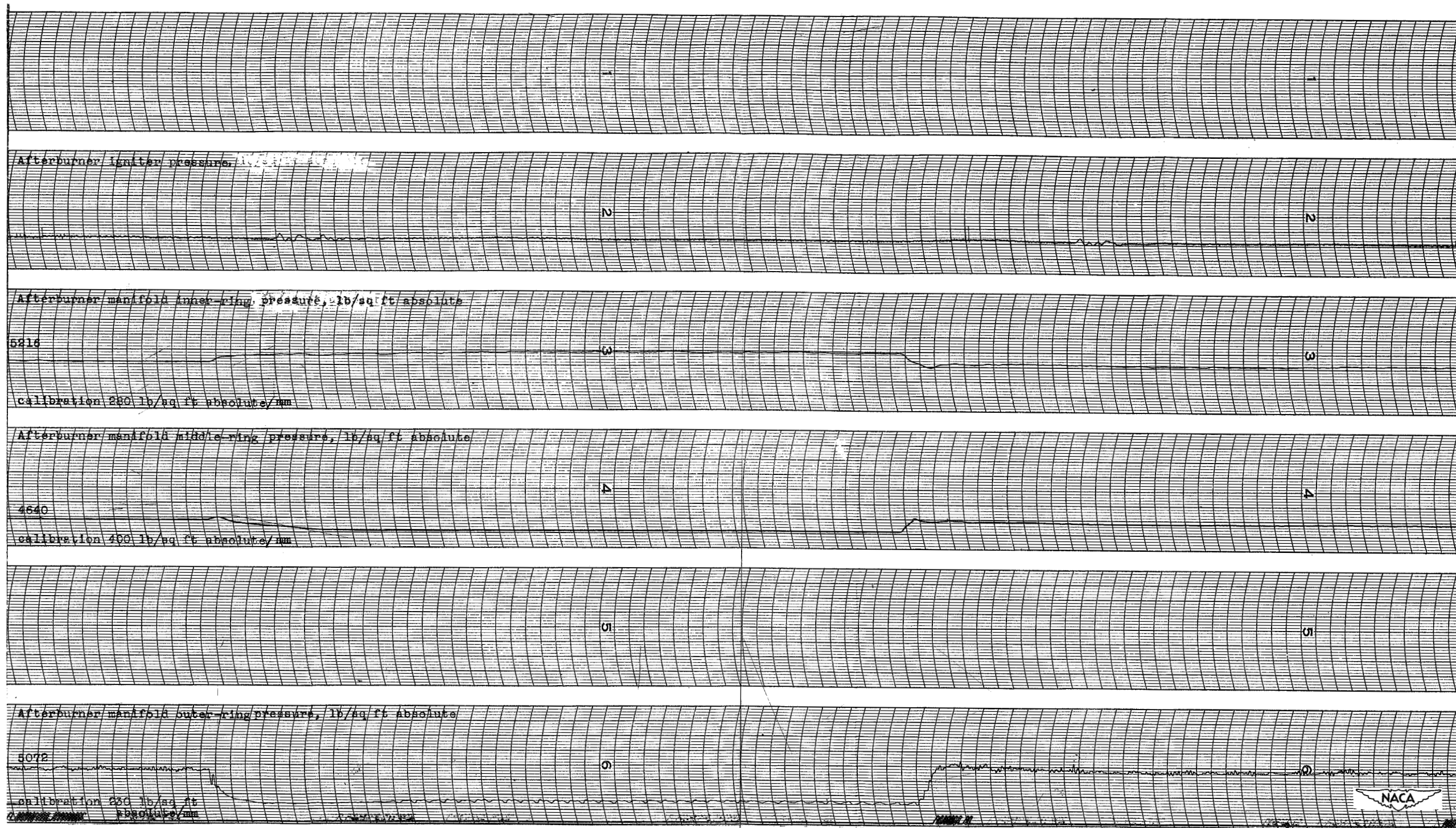


Figure 48. - Concluded. Transient operation of automatically controlled engine with afterburner. Throttle position, 109° to 94° and 94° to 109°; altitude, 45,000 feet; nominal ram pressure ratio, 1.4; boost pump inlet pressure, 18 pounds per square inch.