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RESEARCH MEMORANDUM

for the

Air Material Command, U. S. Air Forces

PRELIMINARY TRANSIENT PERFORMANCE DATA

ON THE J73 TURBOJET ENGINE

II - ALTITUDE, 35,000 FEET

By Robert J. Lubick and Adam E. Sobolewski

Lewis Flight Propulsion Laboratory
Cleveland, Ohio

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PRELIMINARY TRANSIENT PERFORMANCE DATA ON THE J73 TURBOJET ENGINE

II - ALTITUDE, 35,000 FEET

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SUMMARY

A program was undertaken to determine the J73 turbojet engine compressor stall and surge characteristics and combustor blow-out limits encountered during transient engine operation. Data were obtained in the form of oscillograph traces showing the time history of several engine performance parameters with changes in engine fuel flow. The data presented in this report are for step changes in fuel flow at an altitude of 35,000 feet, at flight Mach numbers of 0.3, 0.8, and 1.2, and at several engine-inlet temperatures.

INTRODUCTION

One phase of the altitude-performance investigation of the J73 turbojet engine conducted at the NACA Lewis laboratory consisted in determining the compressor stall and surge characteristics and the combustor blow-out limits encountered during and immediately following rapid changes in engine fuel flow.

The data were obtained on oscillograph traces which showed the time history of several engine parameters following a change in fuel flow. The preliminary data presented herein were obtained at an altitude of 35,000 feet, at flight Mach numbers of 0.3, 0.8, and 1.2, and at several engine-inlet temperatures. Similar data are presented in preliminary form in references 1 and 2 for altitudes of sea level, 15,000, and 45,000 feet at several flight Mach numbers.

The preliminary data which appear in this report consist of reproductions of oscillograph traces obtained at various operating conditions. A check on the accuracy of the calibration values listed on the oscillograph traces has been made but no analysis of the data is presented.

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APPARATUS

Engine and Installation

The J73 turbojet engine used in this investigation has a thrust of approximately 9000 pounds, a rated engine speed of 7950 rpm, and an exhaust-gas temperature of 1185° F (1645° R). The engine is normally equipped with an hydraulic control system which was inoperative during this phase of the investigation. For these tests, the fuel system was so modified that fuel flow was a function of fuel-valve position only. Other engine components are a 12-stage axial-flow compressor with variable inlet guide vanes, an annular-type combustor with 10-cannular-type chambers, a two-stage axial-flow turbine, and a fixed-area exhaust nozzle.

The engine was mounted in a 14-foot diameter altitude chamber. A group of automatic throttle valves was incorporated at both inlet and exhaust ends of the test chamber to provide control of simulated altitude and ram-pressure ratio.

Instrumentation

The transient responses of the engine variables were recorded on a multiple channel, direct-inking, magnetic motor oscillograph. The oscillograph chart speed was 5 units per second.

The location of the measuring stations are shown in figure 1. The sensing devices used for indicating variations in the performance parameters are given in table I. Inasmuch as the total-pressure profile at the engine inlet was flat, it was possible to select almost any total- or static-pressure sensor to record on an oscillograph trace or its corresponding calibration gage without introducing errors. In the case of compressor-outlet total pressure, the sensor selected for both the oscillograph and the calibration gage was approximately the average total pressure at that station, as indicated from earlier steady-state data. Appropriate correction factors were employed where necessary for gage error and sensor location.

PROCEDURE

The oscillograph traces were calibrated by operating the engine at several widely different engine operating points and recording the corresponding pen deflections on the oscillograph trace. Fuel step changes were introduced over a range of initial engine speeds at the conditions shown in the following table:

Altitude, ft	Flight Mach number	Inlet guide vane position	Engine-inlet temperature, °F
35,000	0.3	Open	0, 35
	.3	Closed	-5
	.8	Open	-10, 35, 160
	.8	Closed	10, 160
	1.2	Open	35
	1.2	Closed	35

The variable inlet guide vanes, which normally moved from closed to open position at an engine speed of 6800 rpm as speed was increased, were maintained in a fixed closed or open position during all transients of this phase of the investigation.

The size of the fuel step change was increased until limited by either compressor surge or combustor blow-out or until it was felt that large steps in fuel flow would expose the engine to excessively high temperature. Only the traces which were considered pertinent in determining an operating limit are presented. Thus, in general, at any given initial engine speed two traces are shown. One gives the maximum step change in fuel flow obtained without encountering compressor surge or stall. The other gives the minimum step change in fuel flow which produced compressor surge or stall.

During the period of transient engine operation, both the engine-inlet total pressure and the exhaust pressure varied from the initial value. However, the engine operating limit usually occurred before the engine-inlet total pressure or the exhaust pressure changed appreciably. The time history of the behavior of the engine-inlet total pressure during transient engine operation is shown on the oscillograph traces, but the variation of exhaust pressure is not shown. In general, the maximum increase in exhaust pressure was 7 percent of the initial value.

DISCUSSION

The conditions for each oscillograph trace (figs. 2 to 152) presented herein are given in table II. On each set of oscillograph traces the figure legend specifies the engine conditions at the beginning of the change in fuel flow. Each trace is identified by a label below which is given the calibration factor for the trace. As indicated by the calibration factor, all traces are considered linear except the fuel-flow trace which follows the square-law relation. On each trace is shown the initial value of the engine variable. In the case of fuel flow, one or more additional values are given. The arrows on each figure indicate the direction in which the variable is increasing.

Caution should be used in applying the calibration factors to the traces. Although the horizontal or time scale is linear, the vertical scale on all traces is a circular arc. In obtaining the rate of change of any variable or in calculating elapsed time, this curvature must be considered.

Lewis Flight Propulsion Laboratory
National Advisory Committee for Aeronautics
Cleveland, Ohio, July 1, 1953

REFERENCES

1. Sobolewski, Adam E., and Lubick, Robert J.: Preliminary Transient Performance Data on the J73 Turbojet Engine. I - Altitude, Sea Level and 15,000 Feet. NACA RM SE53F22, 1953.
2. McAulay, John E., and Wallner, Lewis E.: Preliminary Transient Performance Data on the J73 Turbojet Engine. III - Altitude, 45,000 Feet. NACA RM SE53F30, 1953.

TABLE I. - INSTRUMENTATION



Measured quantity	Engine station	Steady-state instrumentation	Transient instrumentation	
			Sensor	Range over which frequency response is essentially flat, cps
Fuel flow	-	Rotameter	Aneroid-type pressure sensor, with strain-gage element, connected to measure pressure drop across variable orifice in fuel line	Undetermined
Dynamic pressure at engine inlet	1	Bourdon-type gage	Aneroid-type pressure sensor with strain-gage element	0-10 At sea-level static
Engine-inlet total pressure	1	Bourdon-type gage	Aneroid-type pressure sensor with strain-gage element	0-10 At sea-level static
Compressor-outlet total pressure	2	Bourdon-type gage	Aneroid-type pressure sensor with strain-gage element	0-10 At sea-level static
Compensated exhaust-gas temperature	3	Five paralleled thermocouples connected to self-balancing potentiometer recorder	Six paralleled 20-gage, chromel-alumel, butt-welded thermocouples and electric network to compensate for thermocouple lag	0-30 At sea-level static when used with properly adjusted compensator
Uncompensated exhaust-gas temperature	3	Five paralleled thermocouples connected to self-balancing potentiometer recorder	Six paralleled 20-gage, chromel-alumel, butt-welded thermocouples	0-1 At sea-level static
Engine speed	-	Chronometric tachometer	Direct-current generator with output proportional to engine speed	0-5

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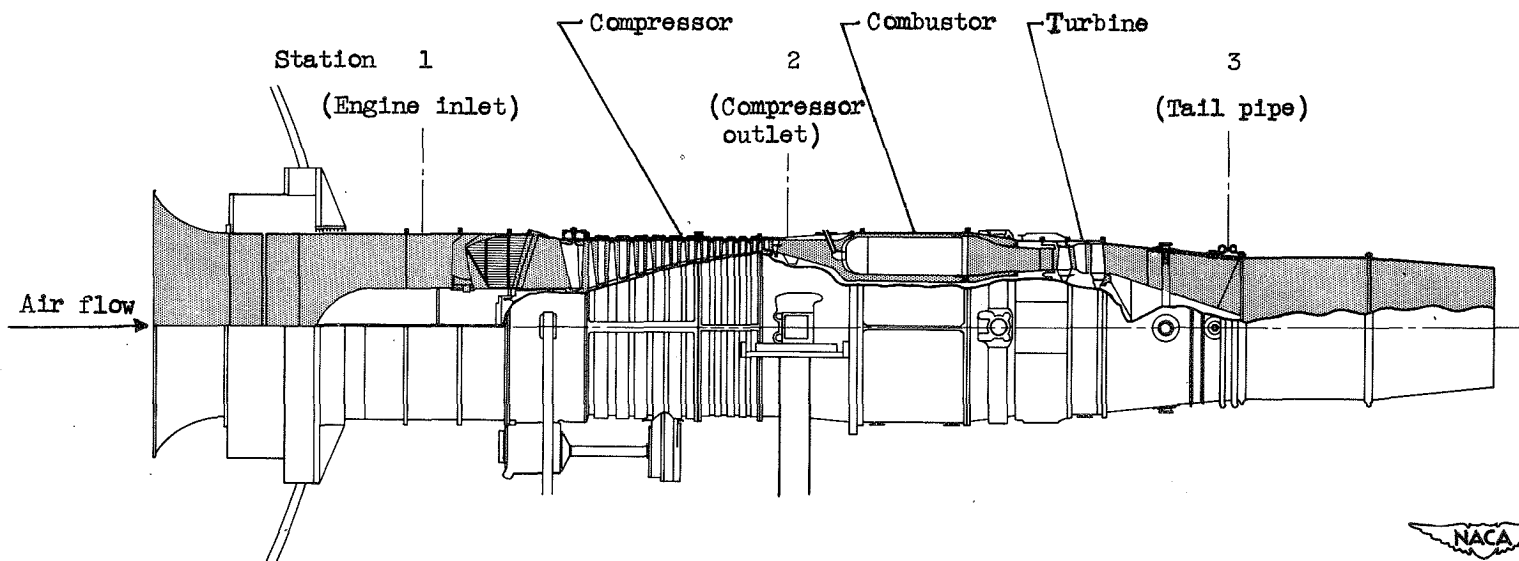
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TABLE II - OSCILLOGRAPH-TRACE CONDITIONS

Figure	Altitude, ft	Flight Mach number	Inlet guide vane position	Engine-inlet temperature, °P		Initial engine speed, rpm		Figure	Altitude, ft	Flight Mach number	Inlet guide vane position	Engine-inlet temperature, °P		Initial engine speed, rpm		
				Nominal	Actual	Nominal	Actual					Nominal	Actual			
2	35,000	0.3	Open	0	-2	5200	5280	78	35,000	0.8	Open	35	39	7200	7500	
3					-2	5210	5280	79					38	7240	7500	
4					0	5800	5780	80					39	7240	7500	
5					0	5770	5770	81					39	7240	7500	
6					2	6200	6210	82					39	7500	7550	
7					2	0	6200	6200					83	39	5020	5020
8					0	6130	6130	84					150	5000	4960	
9					3	6800	6810	85					147	4920	4920	
10					3	6825	6825	86					150	4935	4920	
11					1	7500	7480	87					152	4920	4920	
12					38	5600	5610	88					152	5490	5490	
13					38	5800	5810	89					152	5510	5510	
14					38	5800	5800	90					161	5450	5450	
15					37	6000	5950	91					161	5505	5505	
16					37	5950	5950	92					161	6010	6025	
17					38	6100	6060	93					163	6500	6500	
18					39	6060	6060	94					164	6520	6520	
19					37	6200	6180	95					165	6570	6570	
20					37	6200	6200	96					164	6500	6500	
21					37	6500	6460	97					165	6500	6500	
22					38	6480	6480	98					165	6815	6815	
23					37	6500	6500	99					164	6990	6970	
24					38	6490	6490	100					164	7030	7040	
25					37	6460	6460	101					163	7030	7030	
26					37	6600	6620	102					166	5100	5150	
27					36	7000	7050	103					166	5175	5125	
28					36	6940	6940	104					166	5420	5400	
29					37	7100	7090	105					165	5400	5400	
30					37	7090	7090	106					165	5470	5470	
31					36	7500	7510	107					17	5560	5560	
32	36	7440	7440	108	17	6000	6050									
33	37	7600	7605	109	17	6025	6025									
34	36	7600	7600	110	-2	6750	6750									
35	36	5000	5040	111	-3	6725	6725									
36	-6	5000	5040	112	-2	5415	5415									
37	-6	5500	5060	113	14	5415	5415									
38	-5	5520	5520	114	14	6020	6020									
39	-3	5460	5460	115	11	6500	6500									
40	-3	5490	5490	116	9	6750	6750									
41	-3	5440	5440	117	9	6725	6725									
42	-1	6300	6330	118	9	5400	5415									
43	-1	6350	6350	119	167	5415	5415									
44	-2	6800	6850	120	167	5415	5415									
45	-2	6770	6770	121	167	6020	6020									
46	-10	5200	5180	122	163	6020	6020									
47	-10	5175	5175	123	163	6505	6505									
48	-10	5180	5180	124	164	6505	6505									
49	-8	5500	5475	125	164	6490	6490									
50	-8	5475	5475	126	163	6490	6490									
51	-8	6000	6030	127	163	7035	7035									
52	-6	6030	6030	128	163	7070	7070									
53	-6	6500	6520	129	163	5500	5500									
54	-6	6475	6475	130	32	6020	6020									
55	-8	7100	7085	131	34	6020	6020									
56	-8	7085	7085	132	42	6020	6020									
57	-9	7500	7470	133	34	5980	5980									
58	-10	7530	7530	134	42	6470	6470									
59	-10	7530	7530	135	35	6500	6500									
60	30	5970	5970	136	35	6500	6500									
61	28	5970	5970	137	42	6570	6570									
62	28	5950	5950	138	42	6600	6600									
63	30	6050	6050	139	42	7470	7470									
64	28	5995	5995	140	35	7500	7500									
65	28	6020	6020	141	35	5500	5500									
66	30	5900	5900	142	30	5440	5440									
67	30	6600	6600	143	30	6020	6020									
68	30	6600	6600	144	30	6020	6020									
69	30	6540	6540	145	29	5955	5955									
70	30	6600	6600	146	30	6530	6530									
71	38	7050	7050	147	30	6535	6535									
72	38	7050	7050	148	40	6540	6540									
73	30	6900	6900	149	30	7115	7115									
74	39	7050	7050	150	40	7050	7050									
75	30	7038	7038	151	30											
76	30	6960	6960	152	30											
77	39	7200	7250													





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Figure 1. - Side view of turbojet engine installation showing stations at which instrumentation was installed.

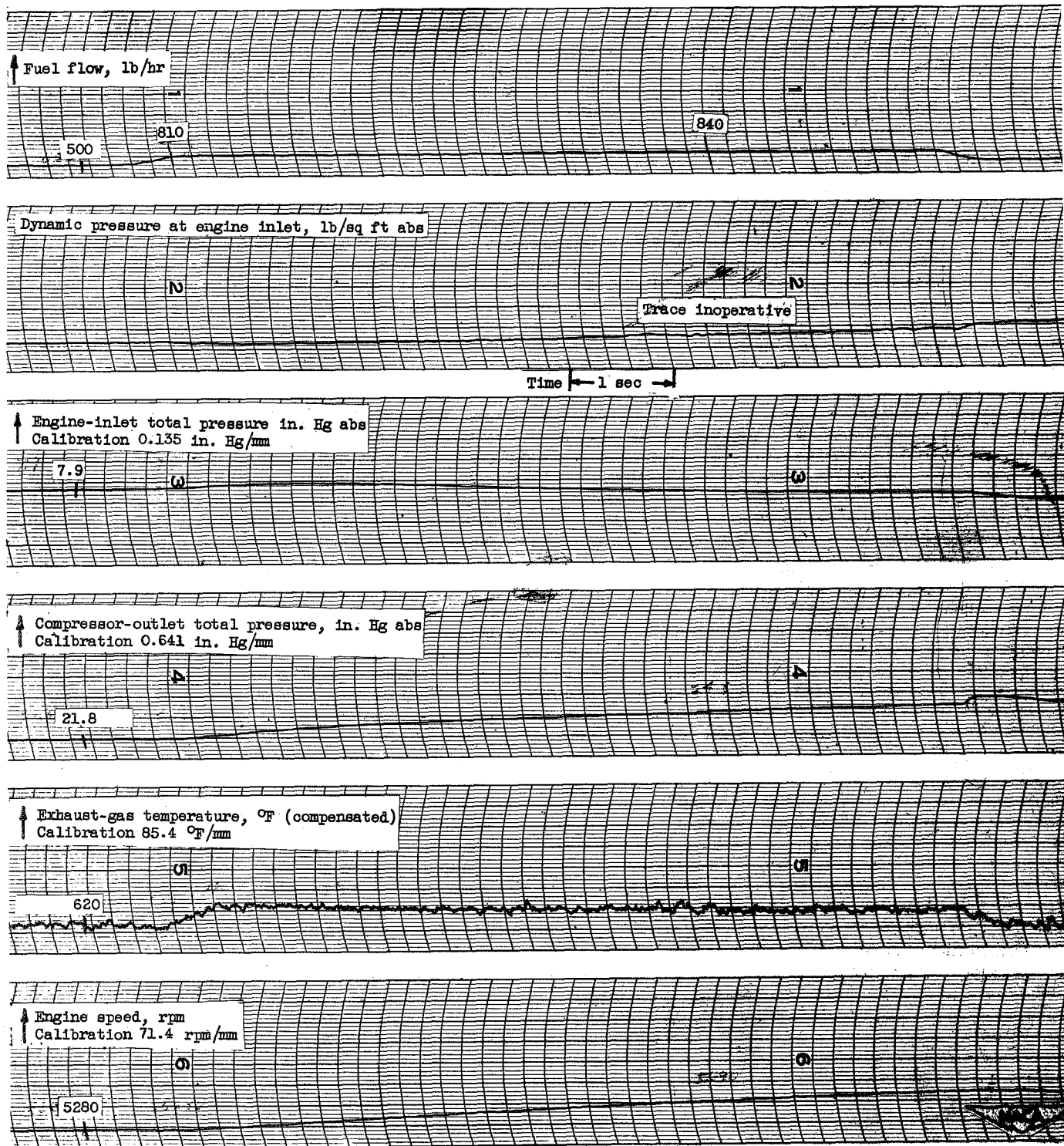


Figure 2

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, -2°F ; inlet guide vanes position, open.

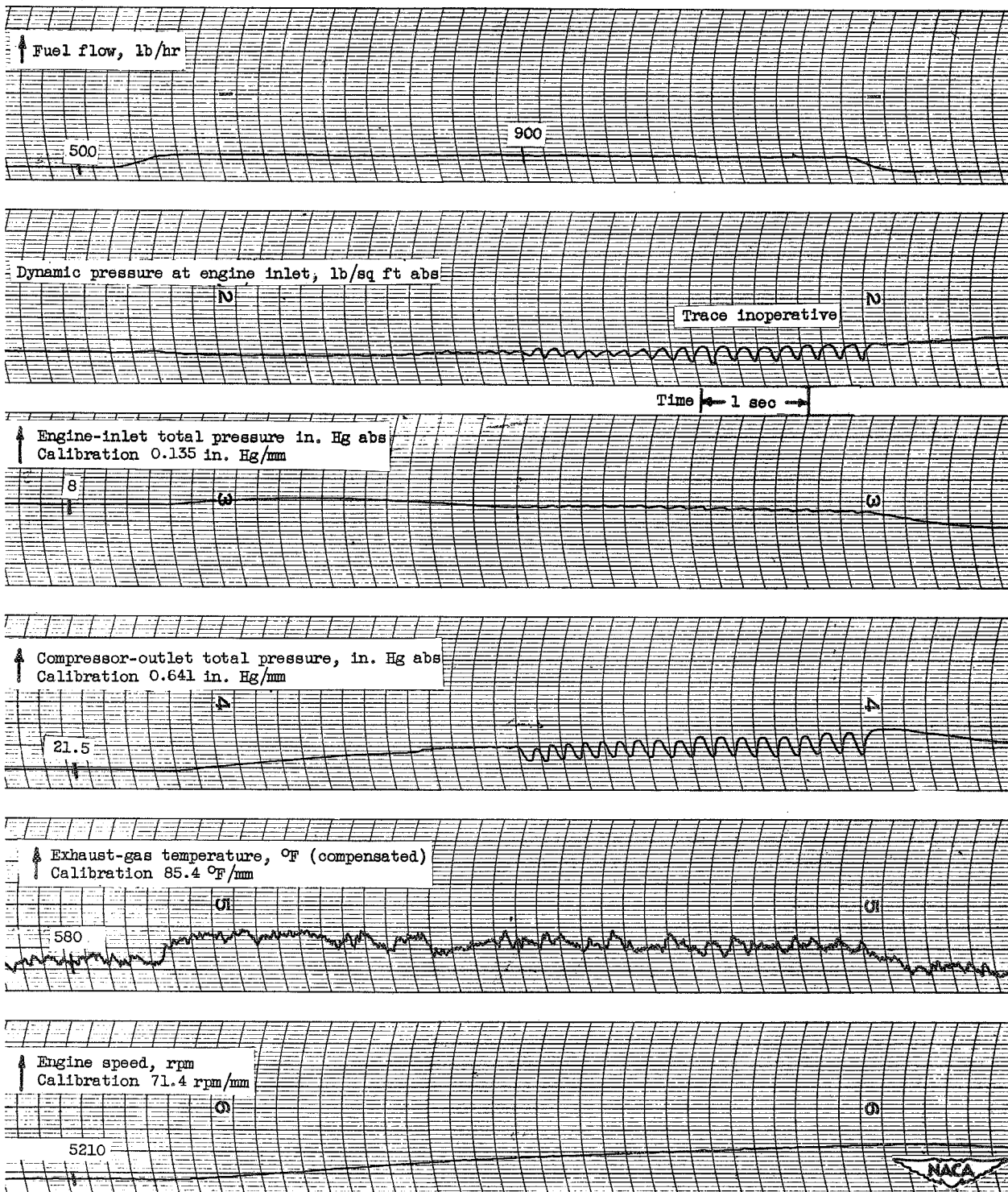


Figure 3
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, -2° F; inlet guide vanes position, open.

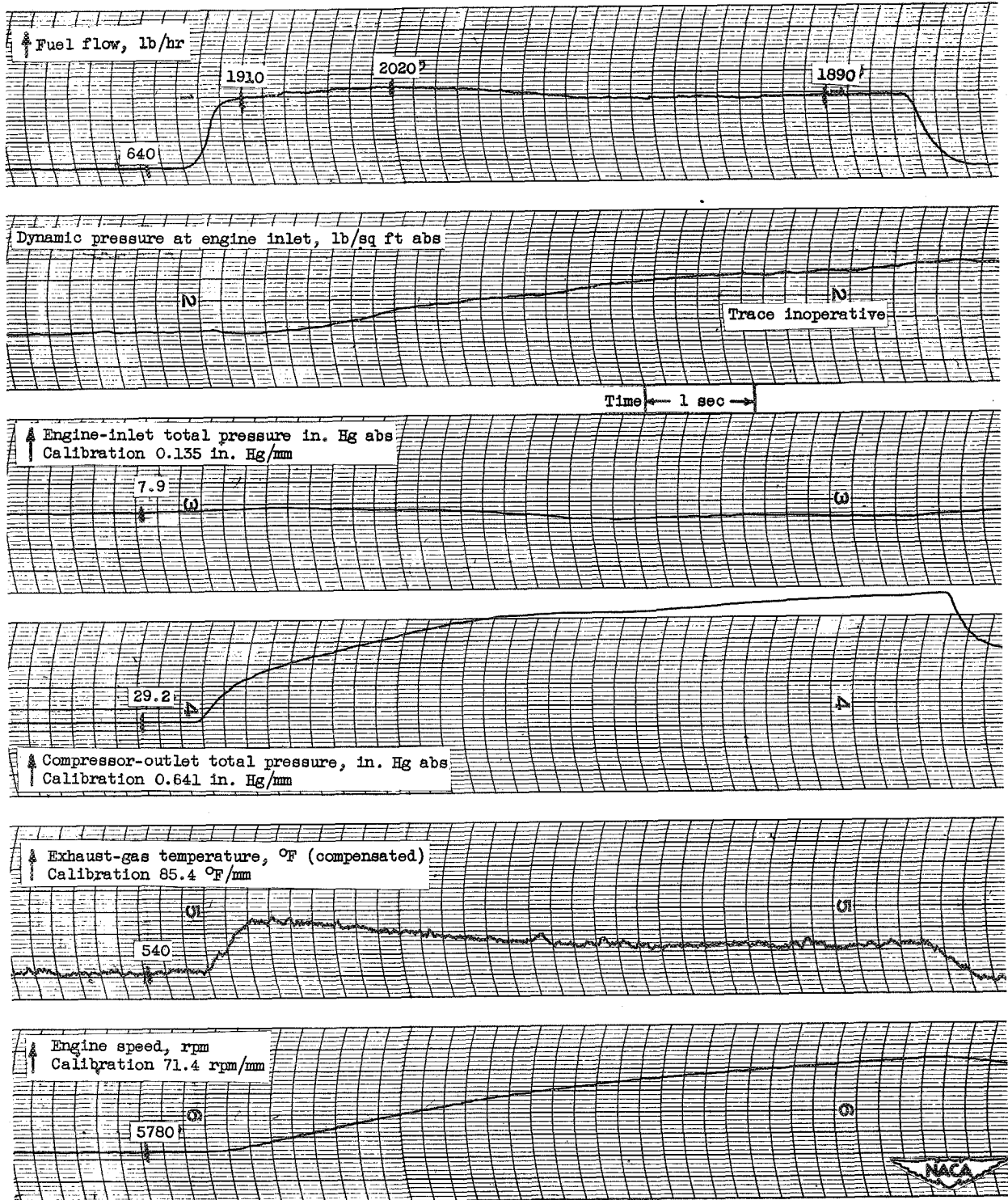


Figure 4

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 0 °F; inlet guide vanes position, open.

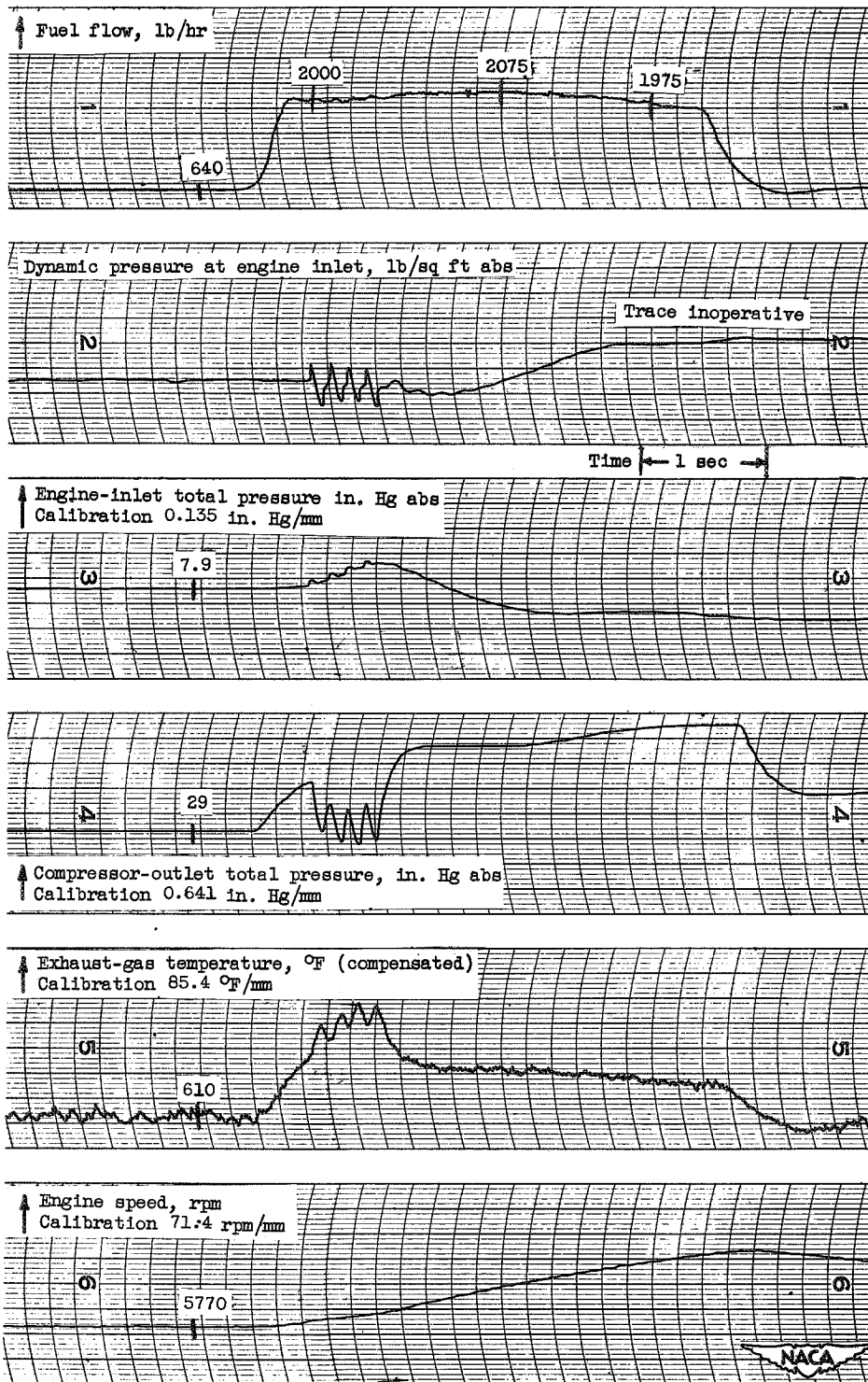


Figure 5

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 0 ° F; inlet guide vanes position, open.

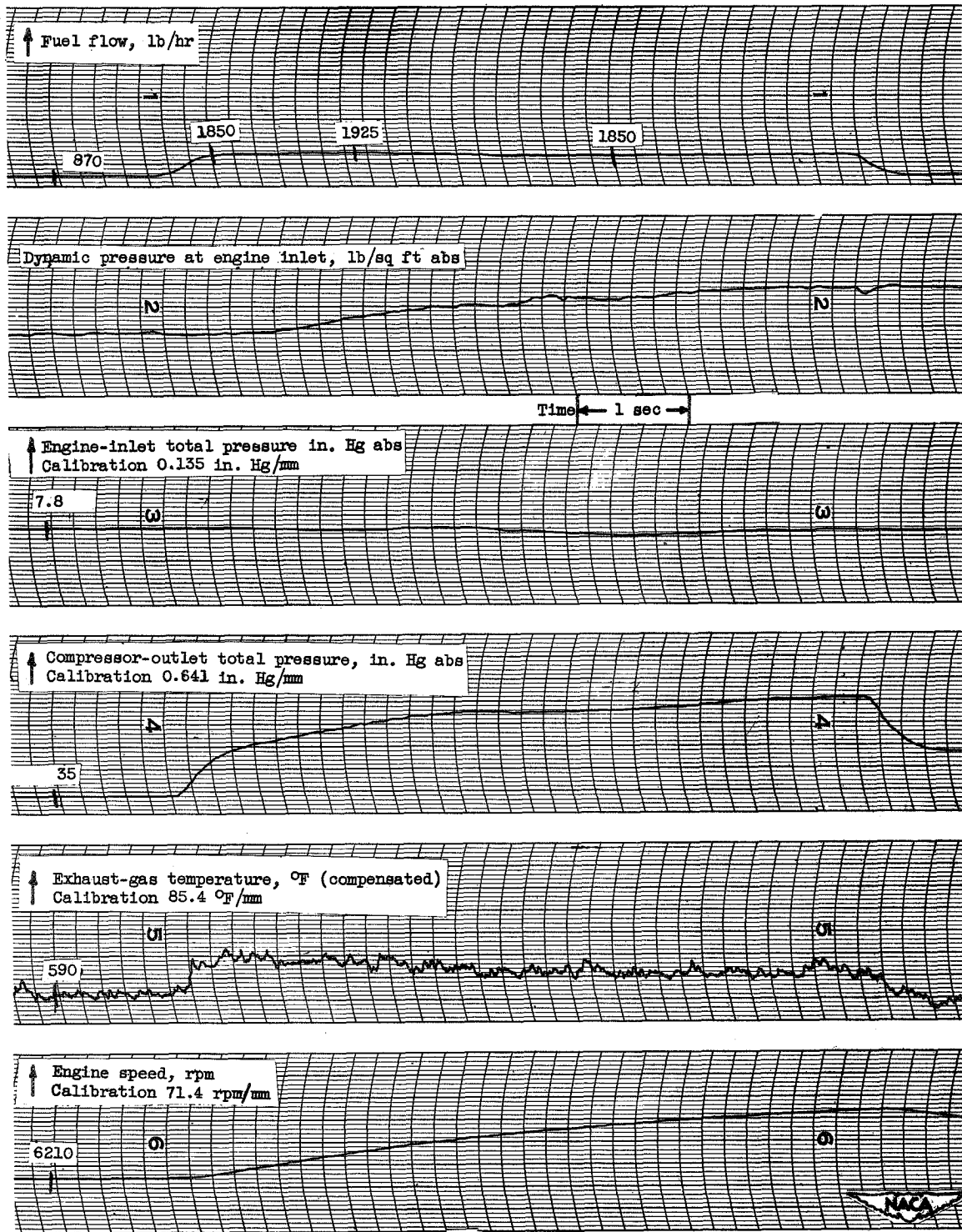


Figure 6

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 2 °F; inlet guide vanes position, open.

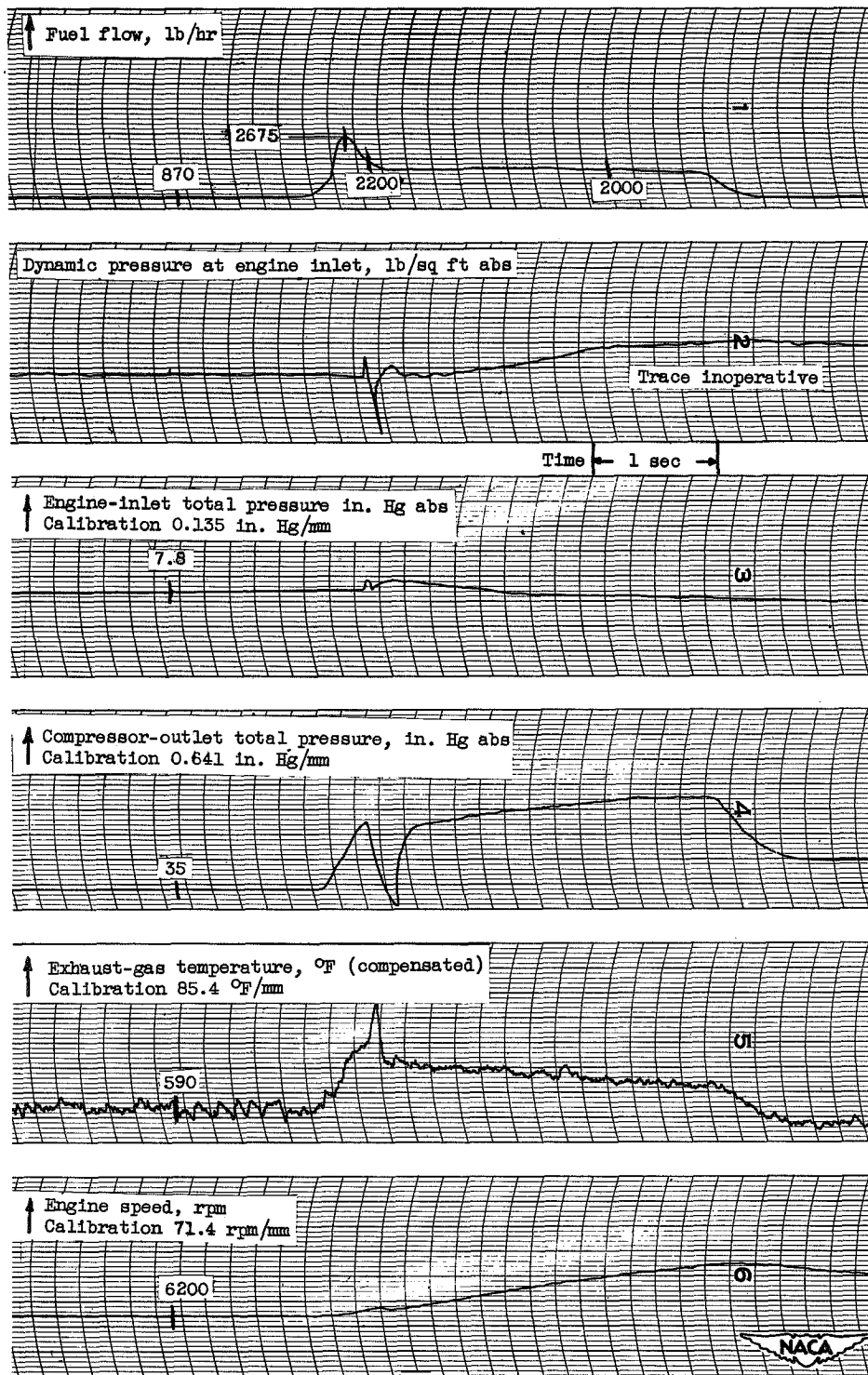


Figure 7

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 2° F; inlet guide vanes position, open.

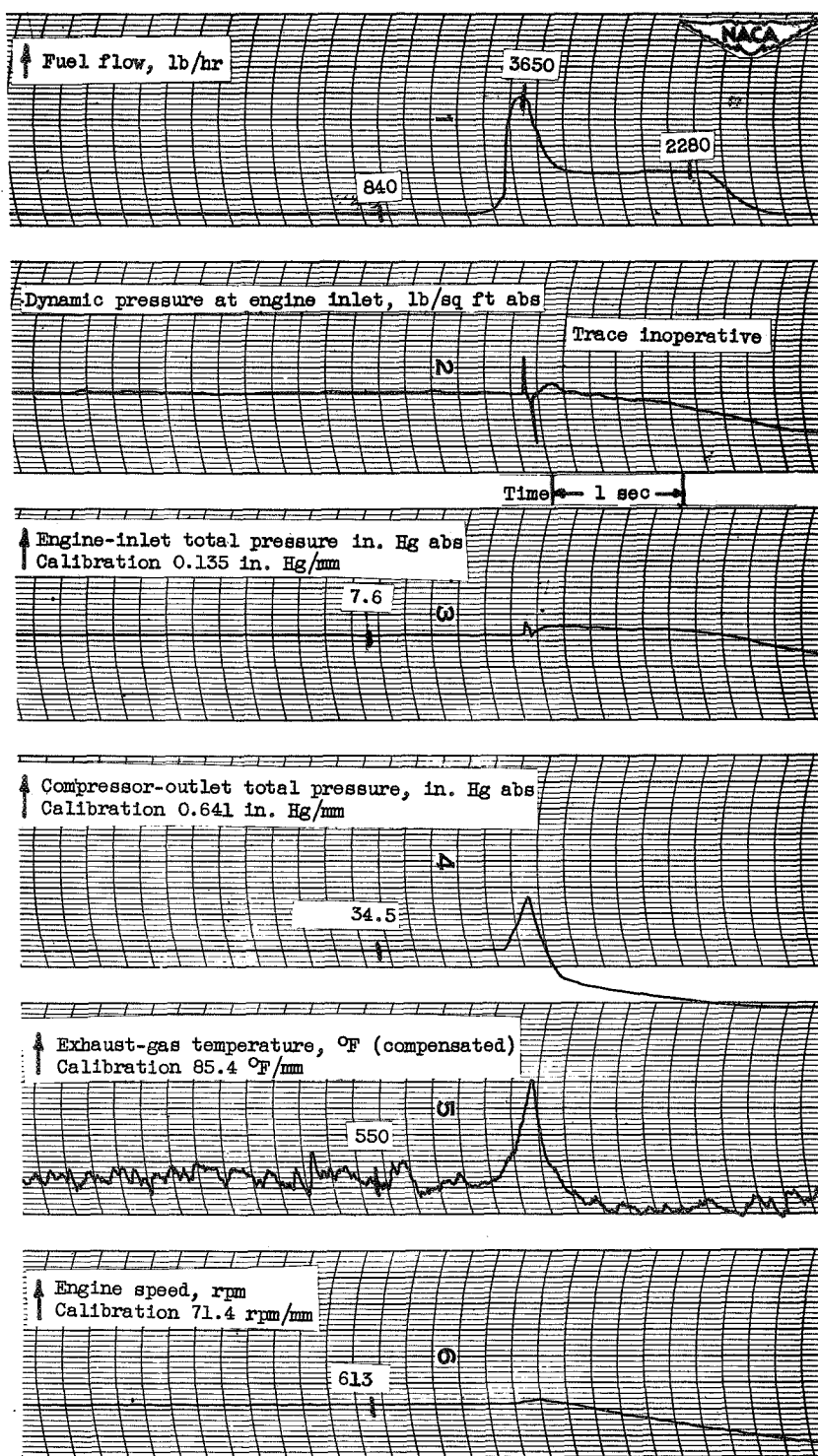


Figure 8

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 0 °F; inlet guide vanes position, open.

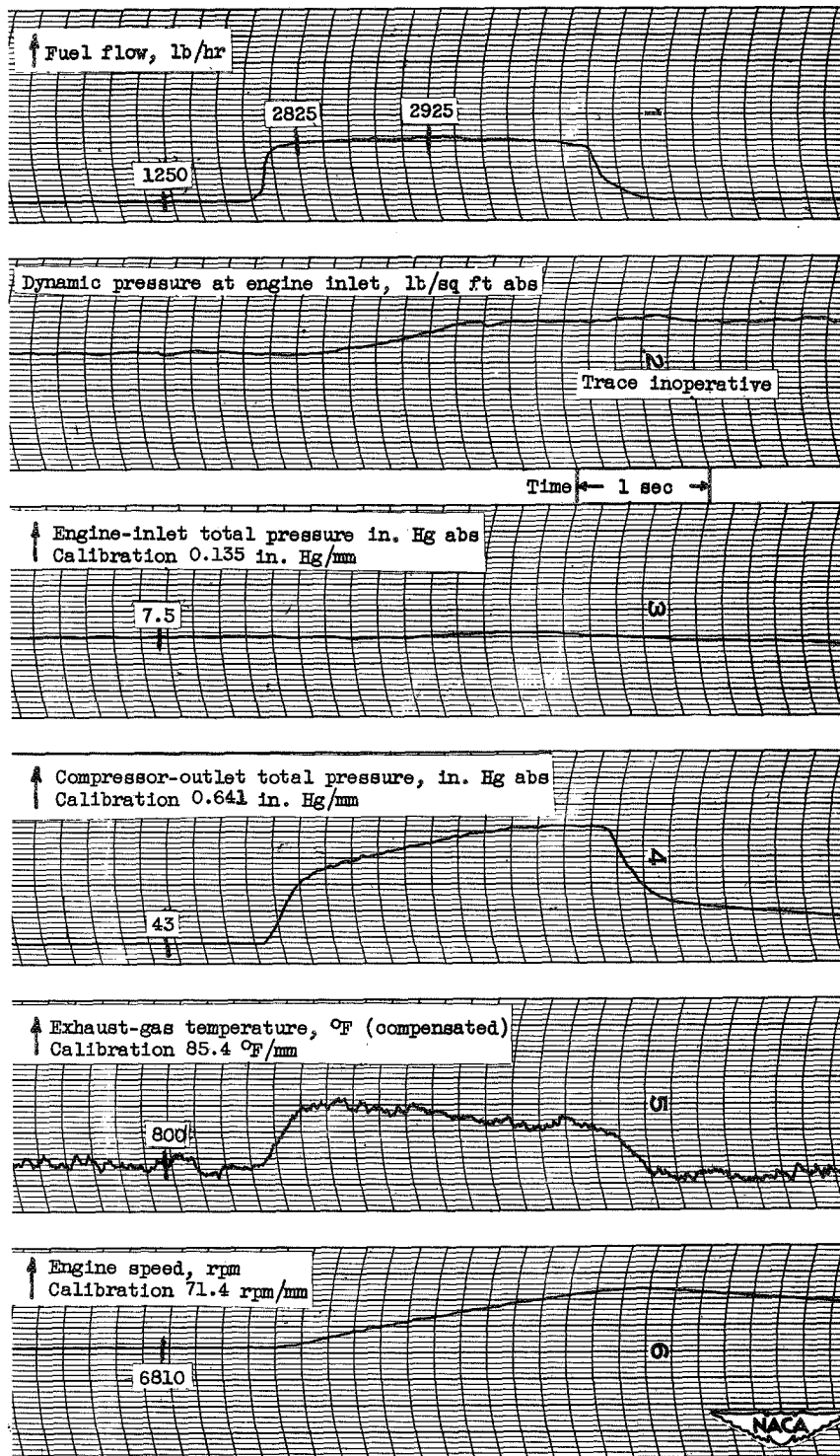


Figure 9
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 3° F; inlet guide vanes position, open.

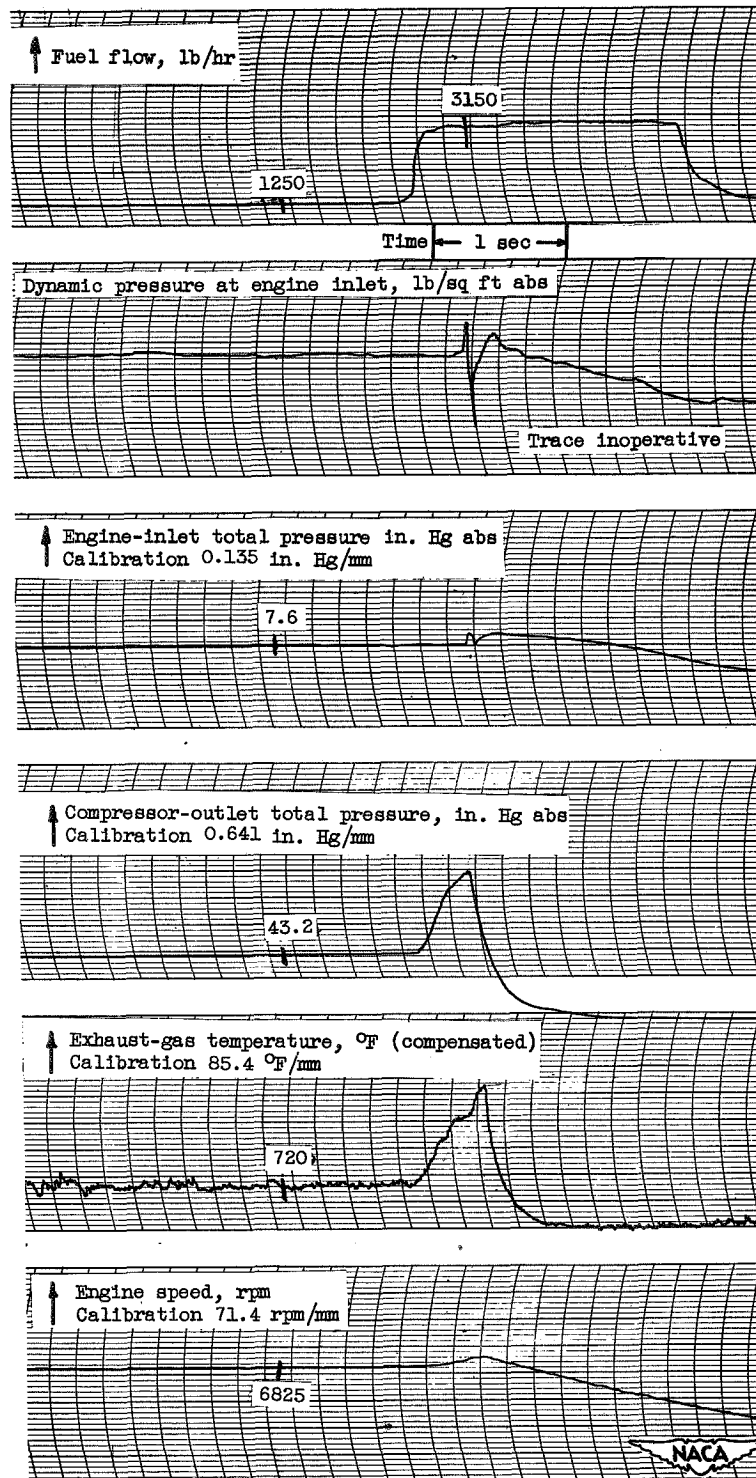


Figure 10

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 3°F ; inlet guide vanes position, open.

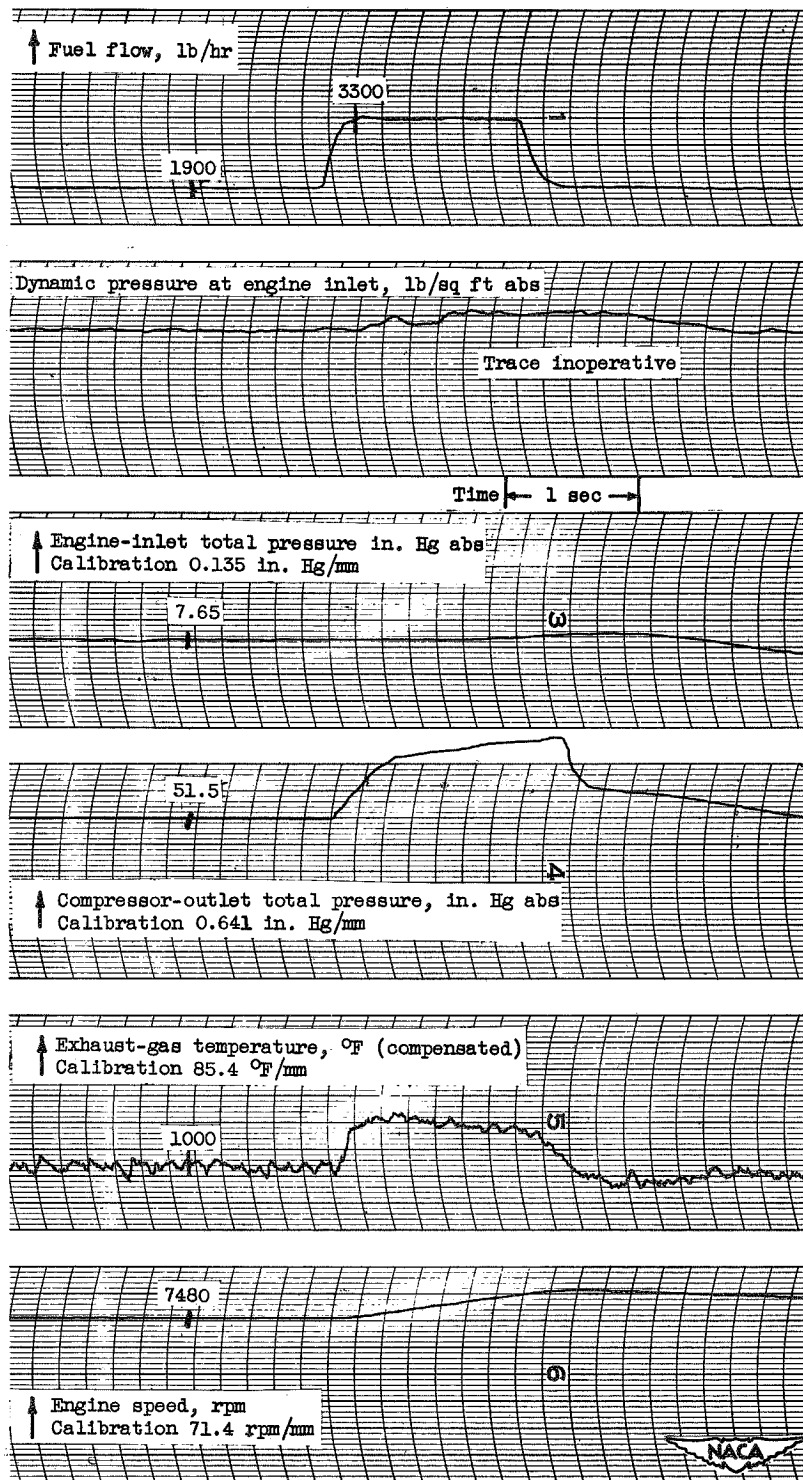


Figure 11

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 1° F; inlet guide vanes position, open.

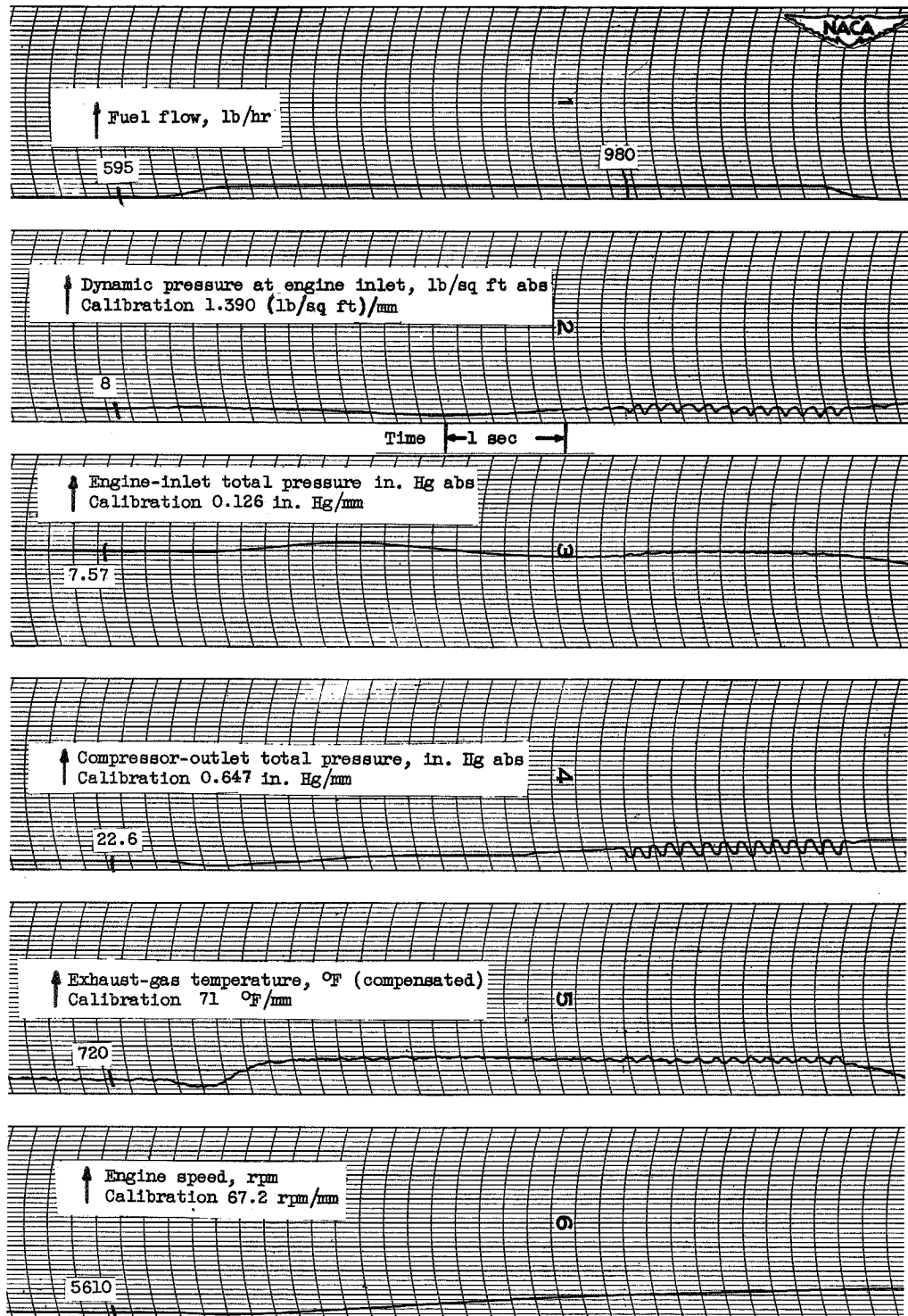


Figure 12

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 38° F; inlet guide vanes position, open.

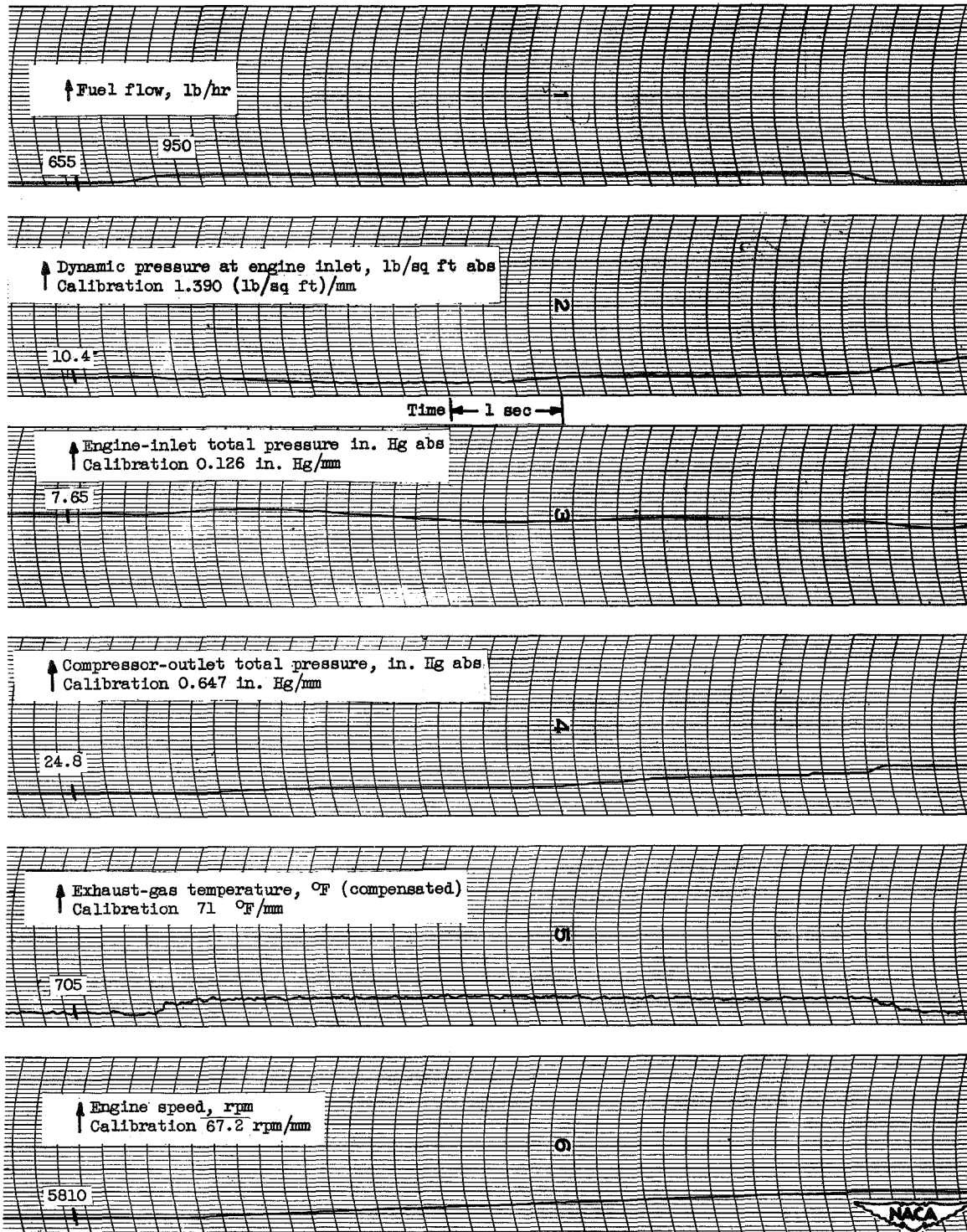


Figure 13

BL 90 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 38° F; inlet guide vanes position, open.

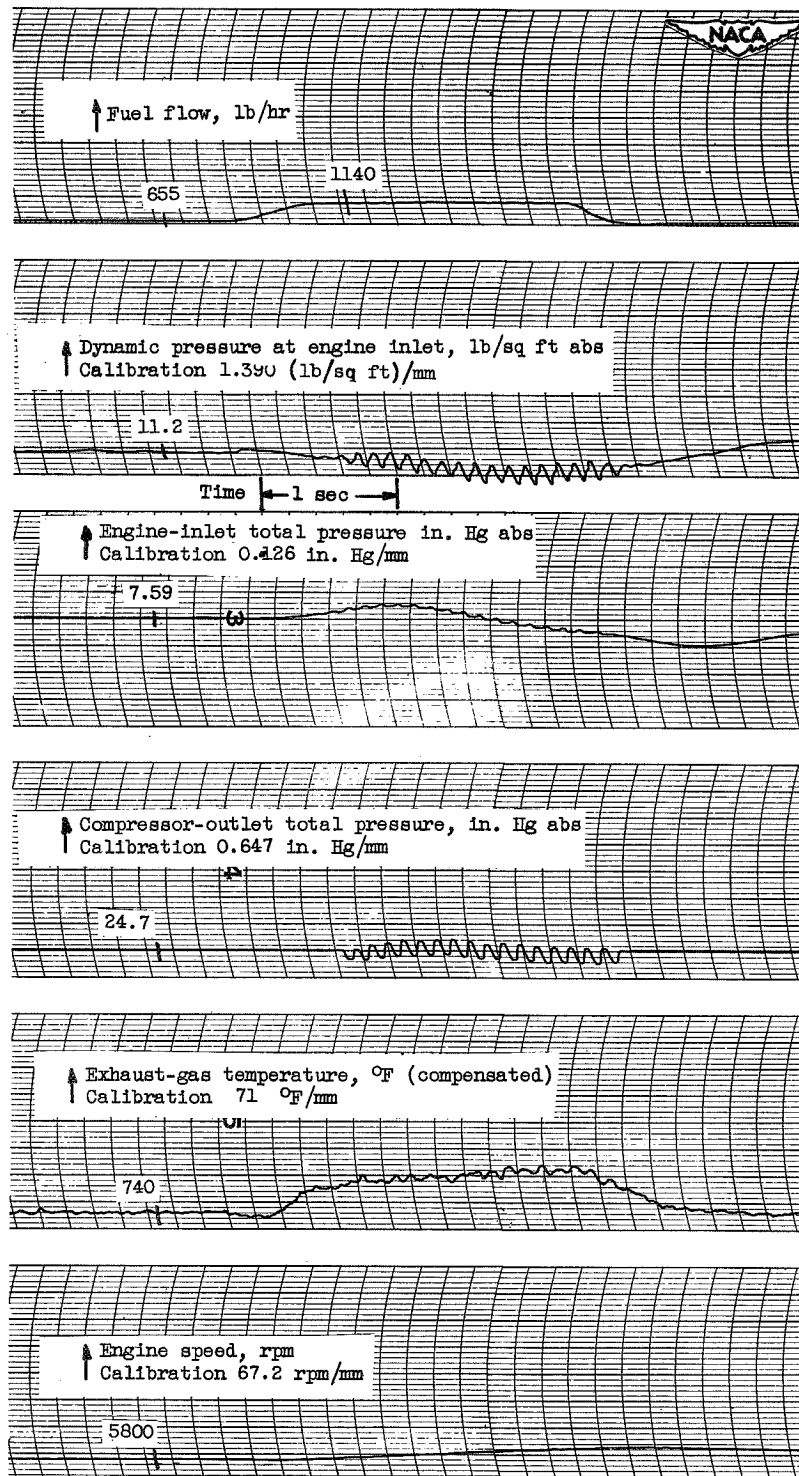


Figure 14

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 38° F; inlet guide vanes position, open.

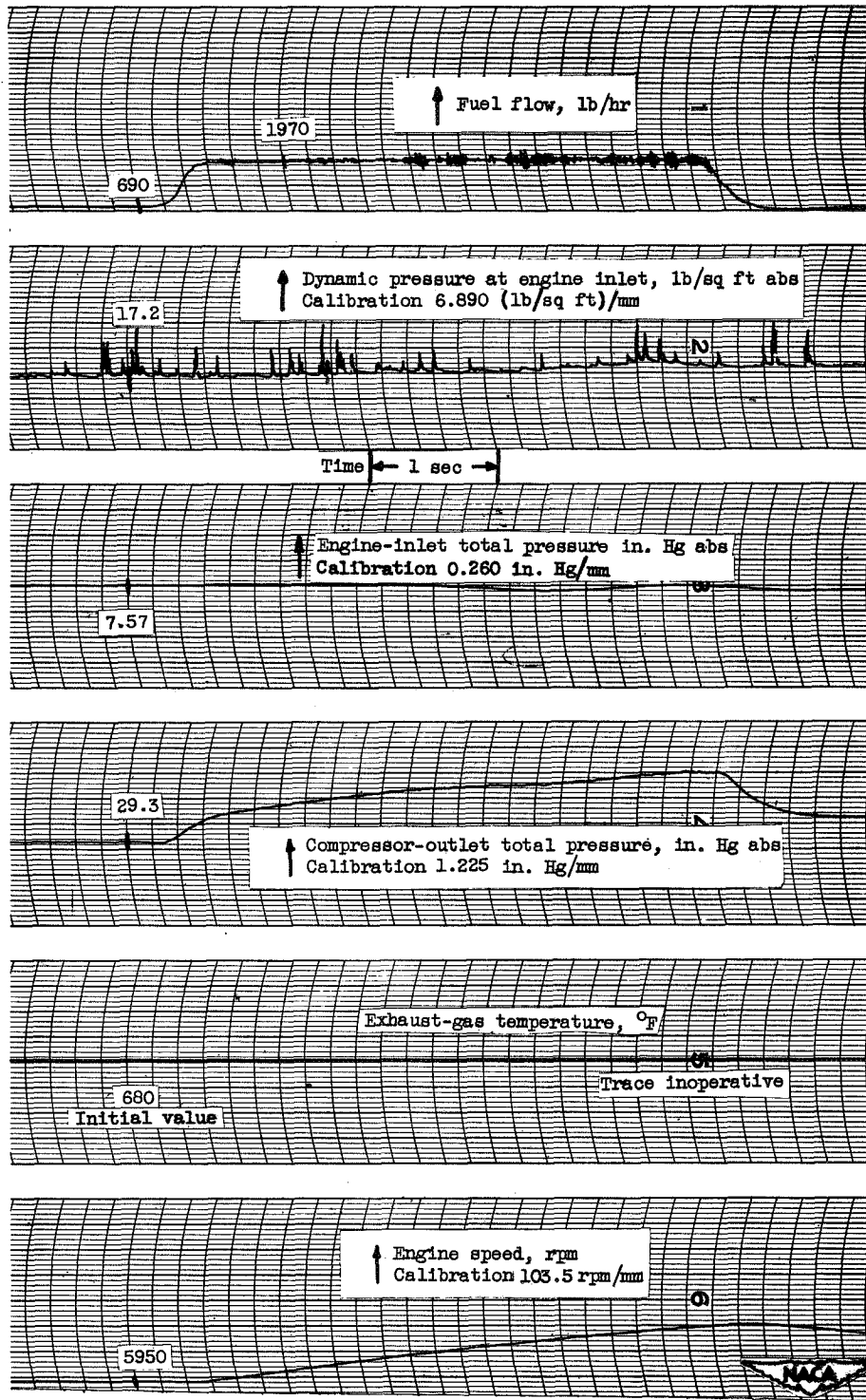


Figure 15

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 37° F; inlet guide vanes position, open.

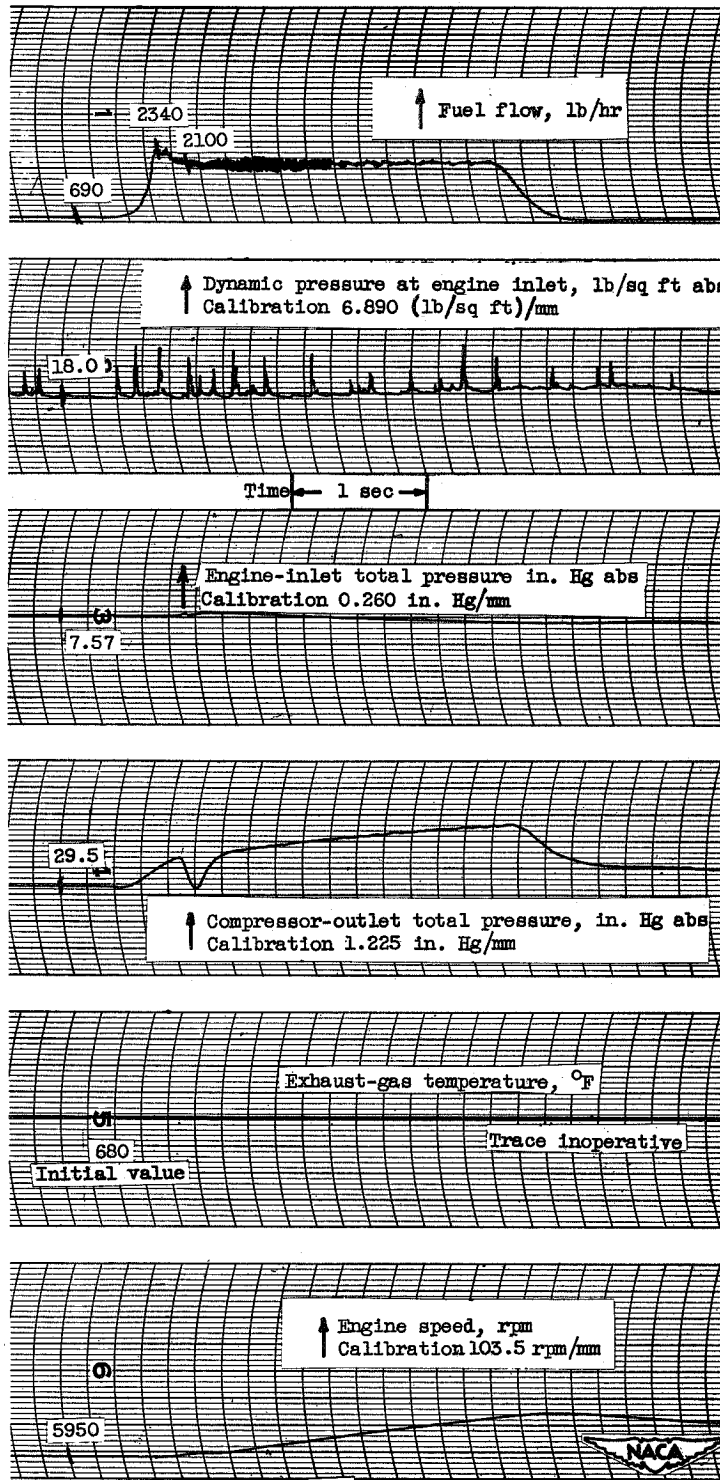


Figure 16

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 37° F; inlet guide vanes position, open.

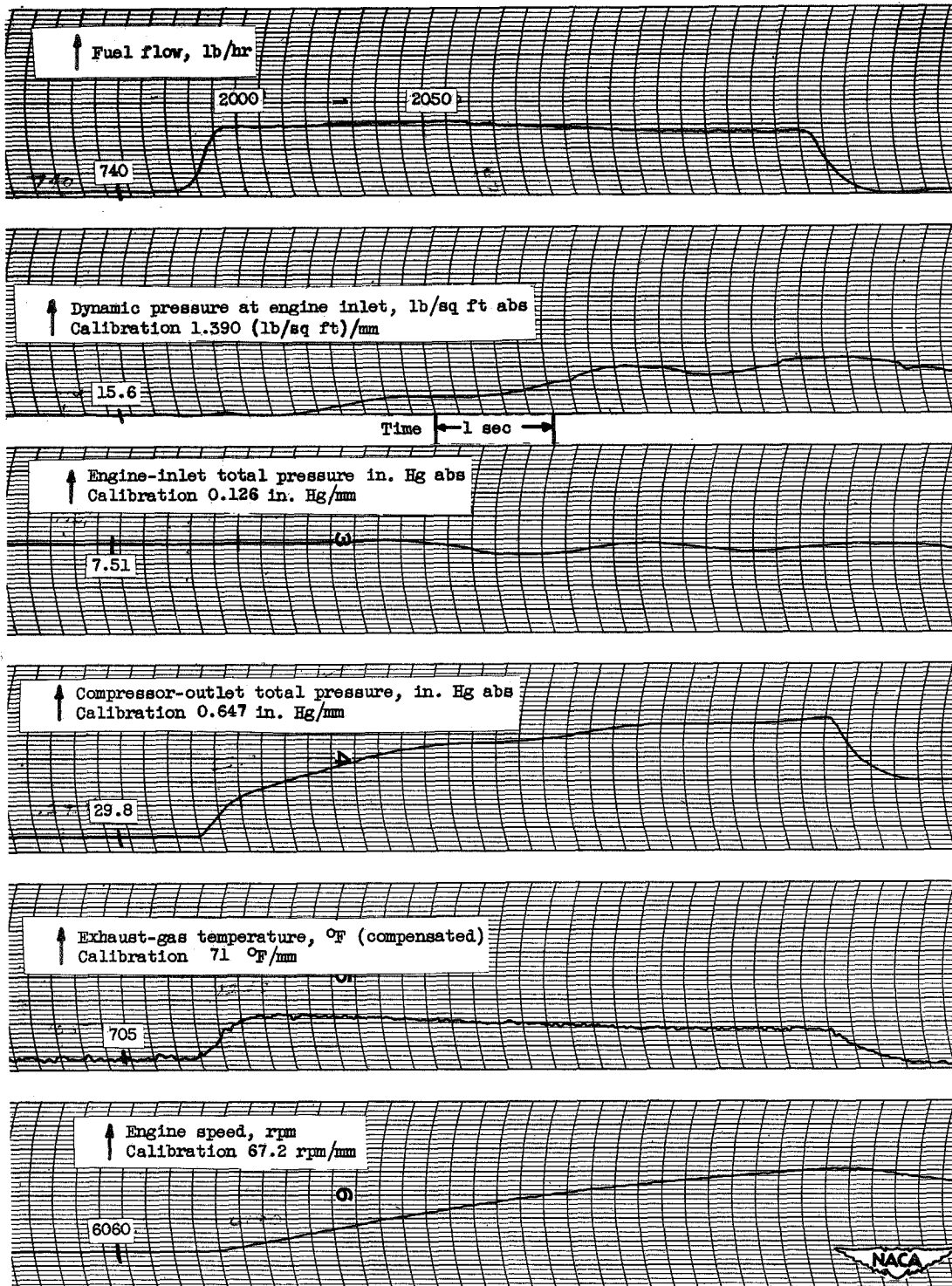


Figure 17
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 38° F; inlet guide vanes position, open.

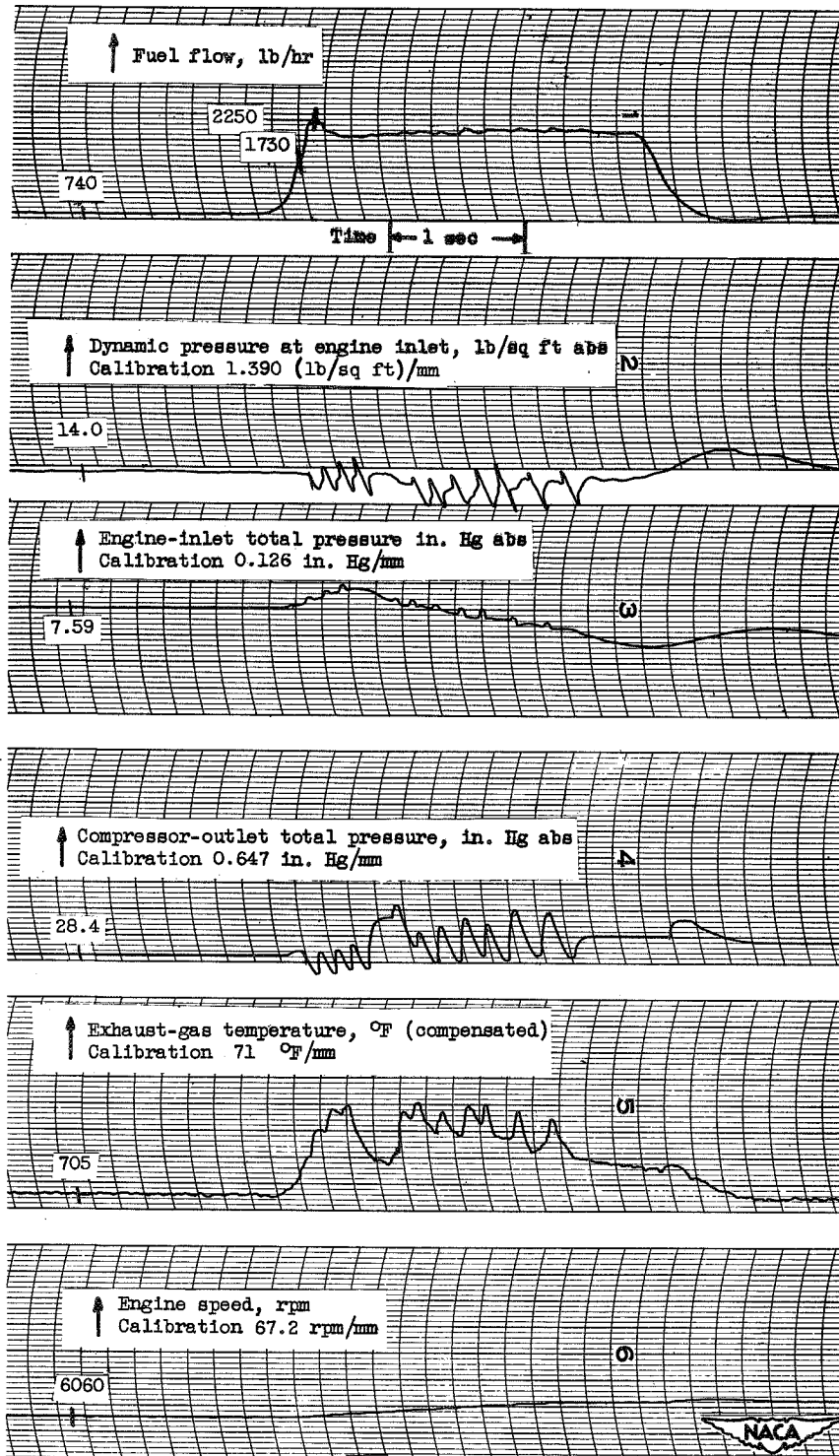


Figure 18

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 38° F; inlet guide vanes position, open.

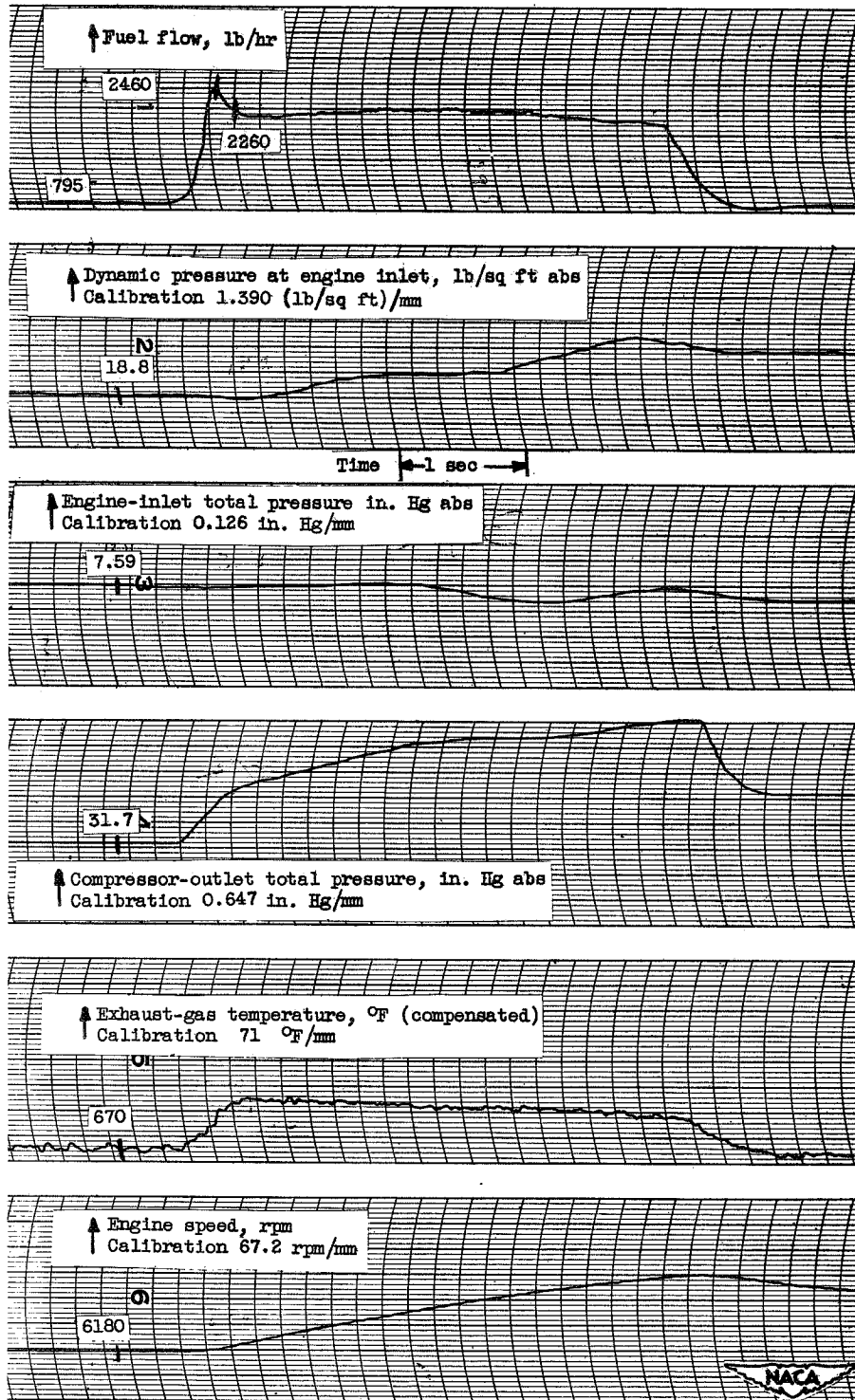


Figure 19

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 37° F; inlet guide vanes position, open.

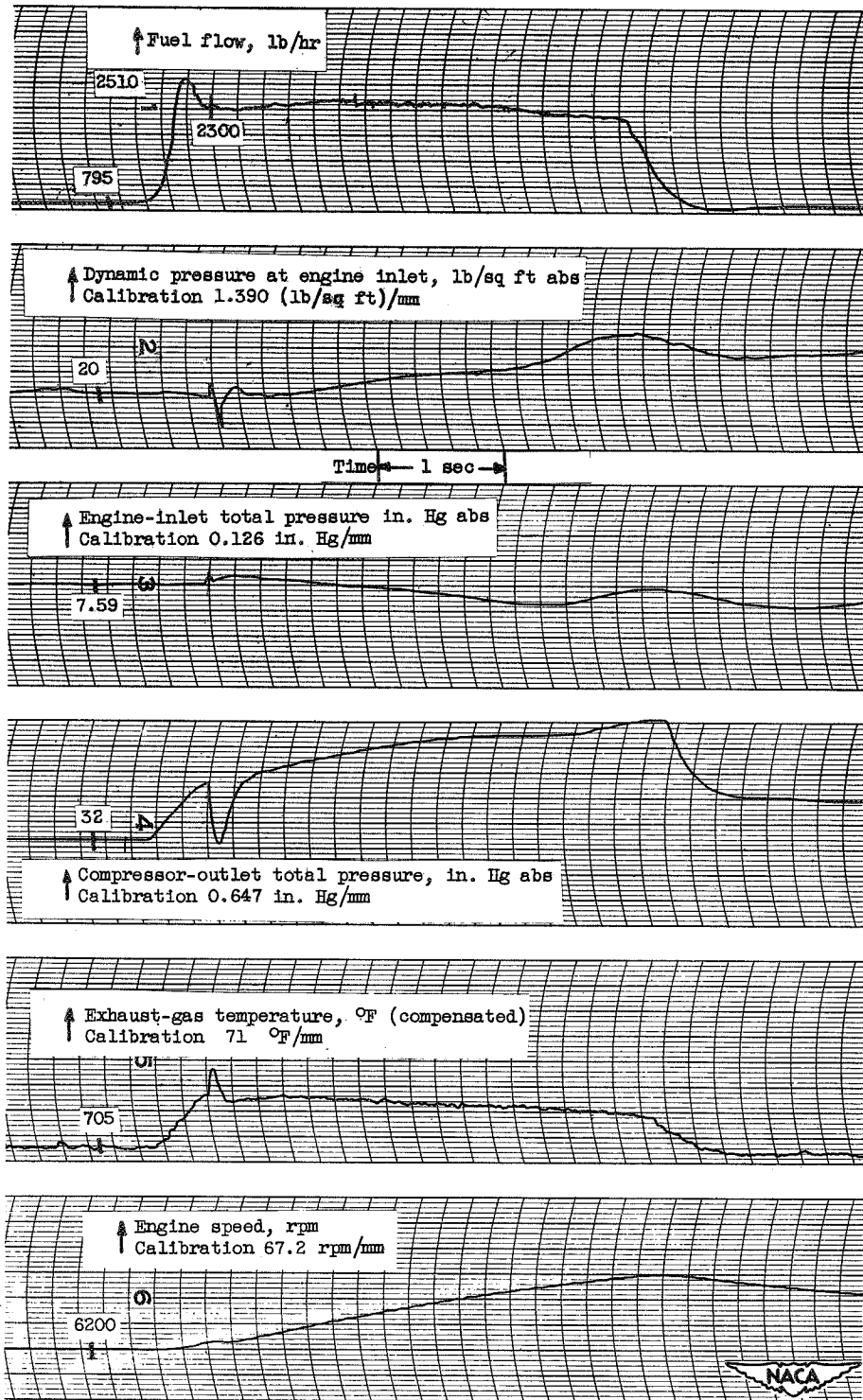


Figure 20
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 37 ° F; inlet guide vanes position, open.

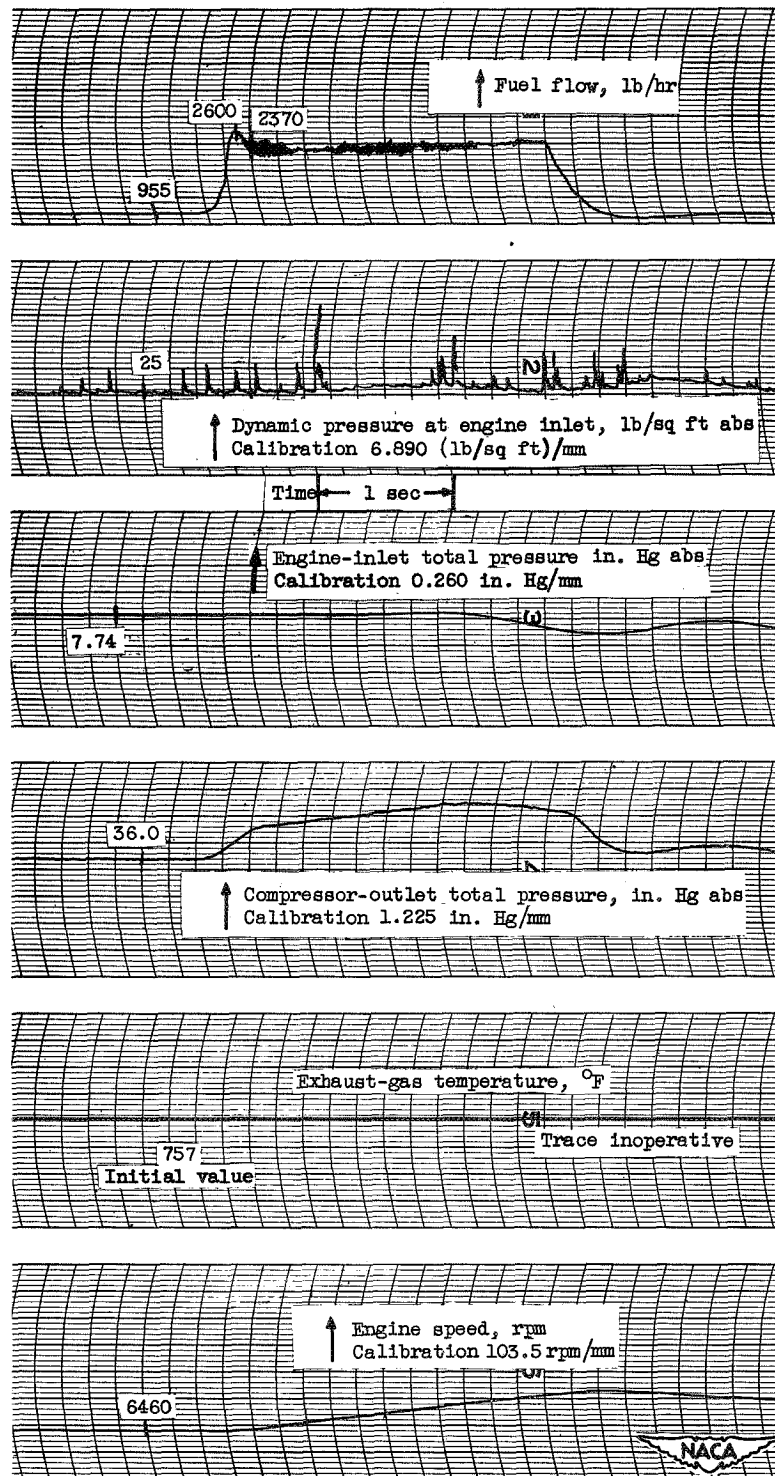


Figure 21
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 37° F; inlet guide vane position, open.

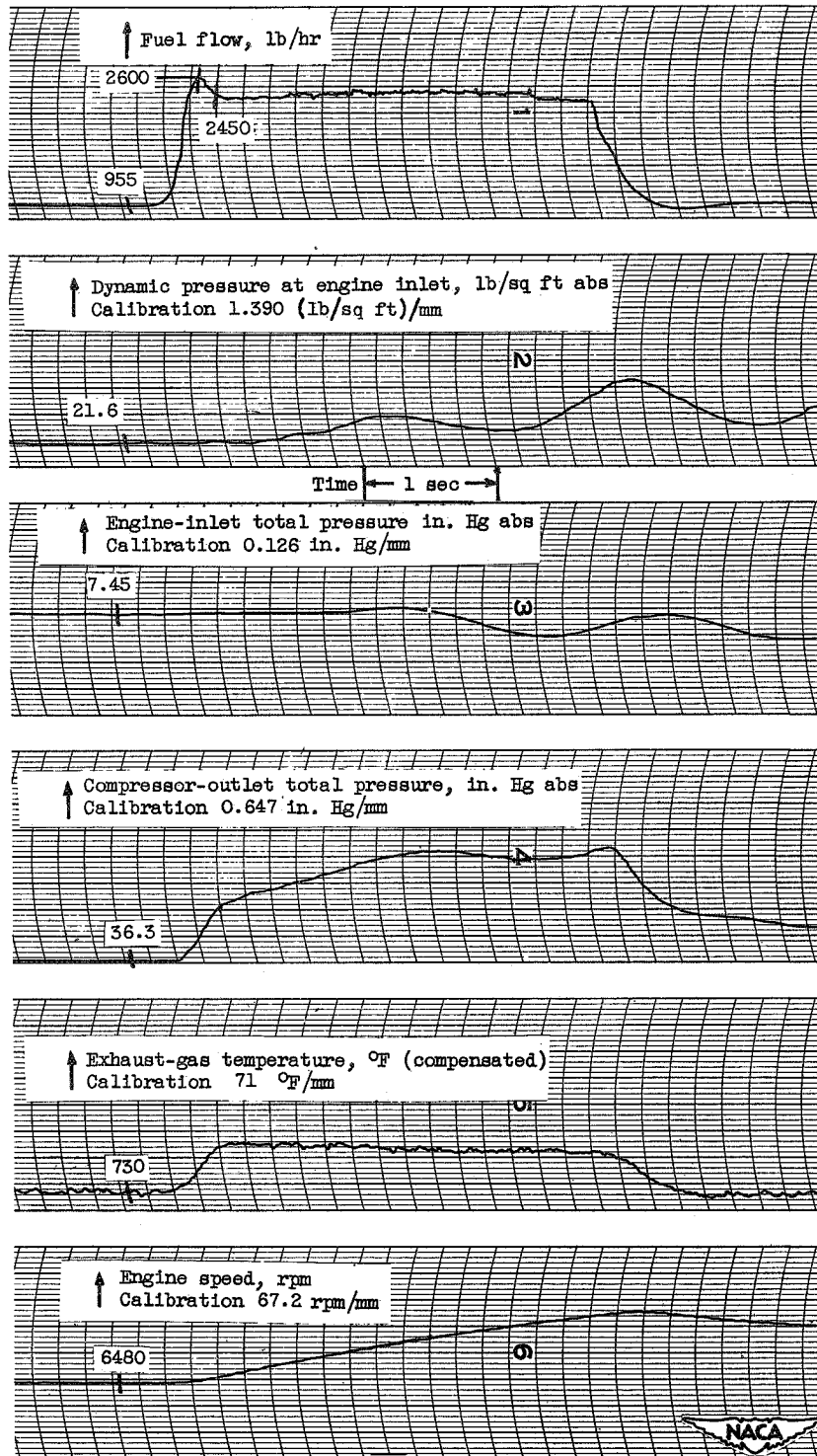


Figure 22

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 38 °F; inlet guide vanes position, open.

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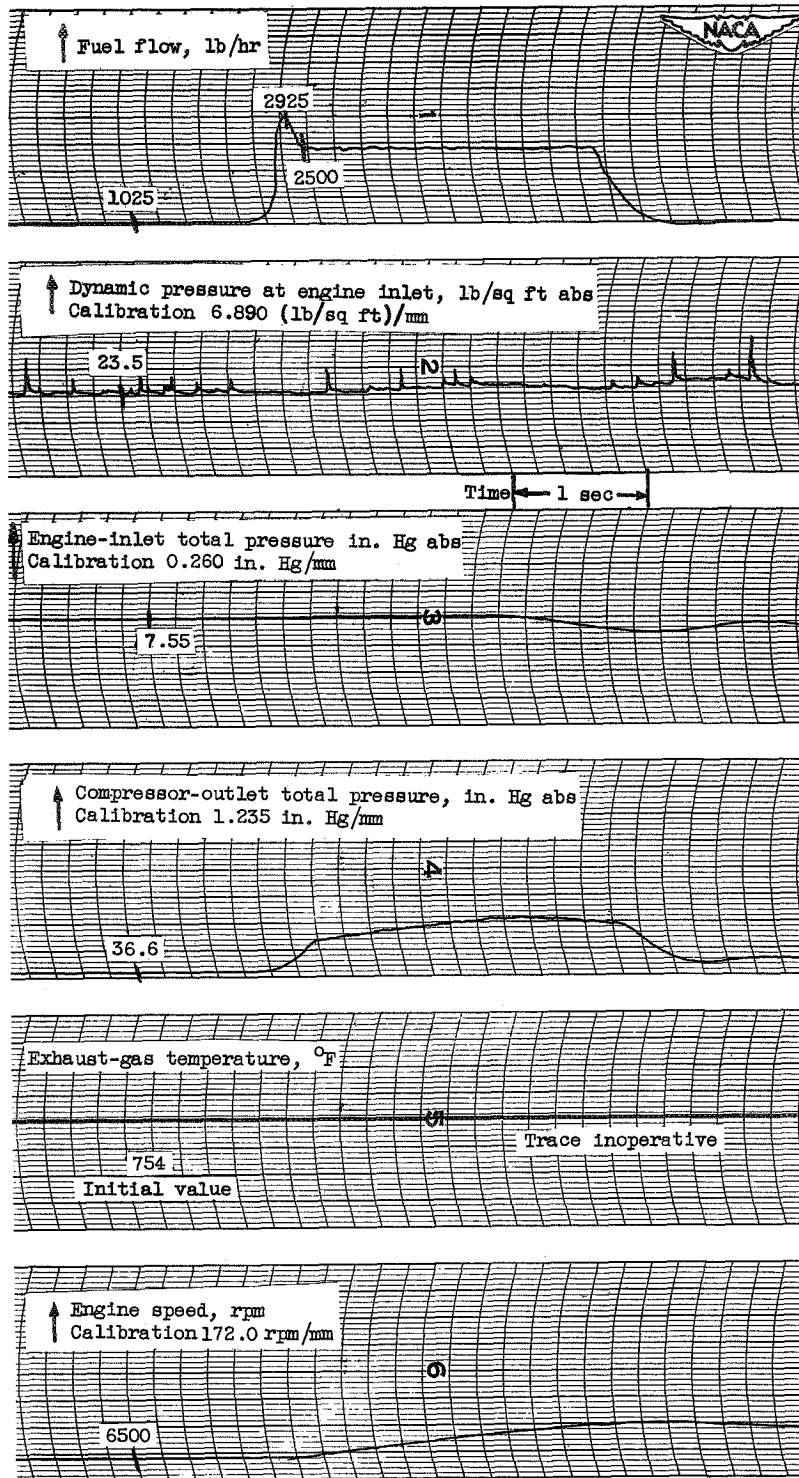


Figure 23

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 37° F; inlet guide vanes position, open.

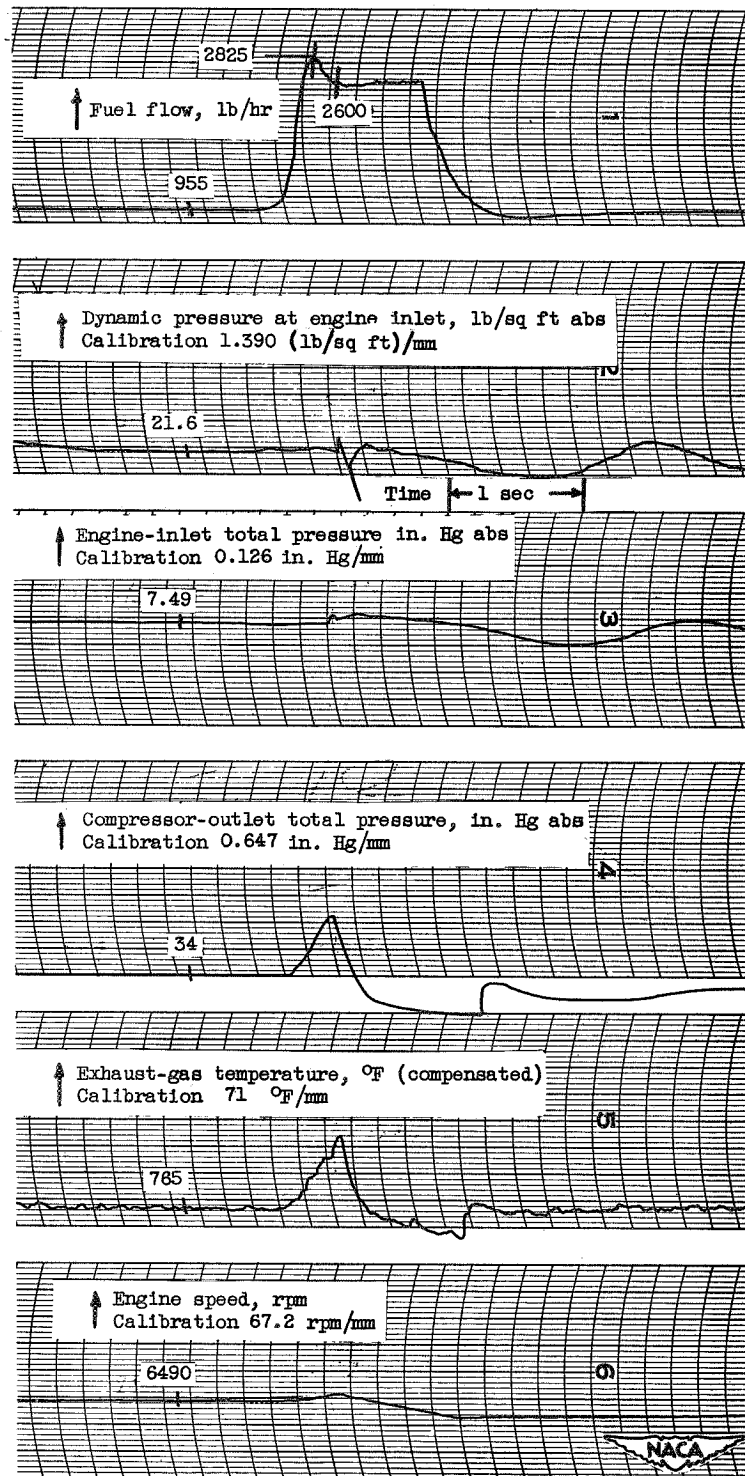


Figure 24

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 38° F; inlet guide vanes position, open.

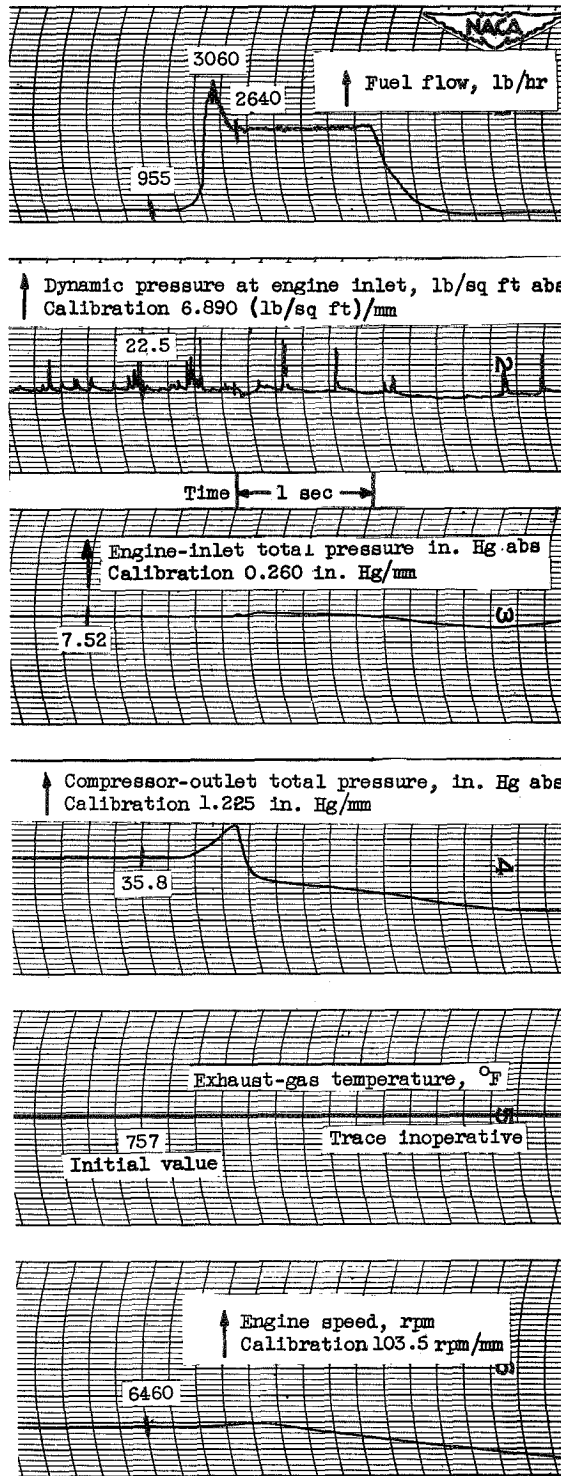


Figure 25

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 37° F; inlet guide vanes position, open.

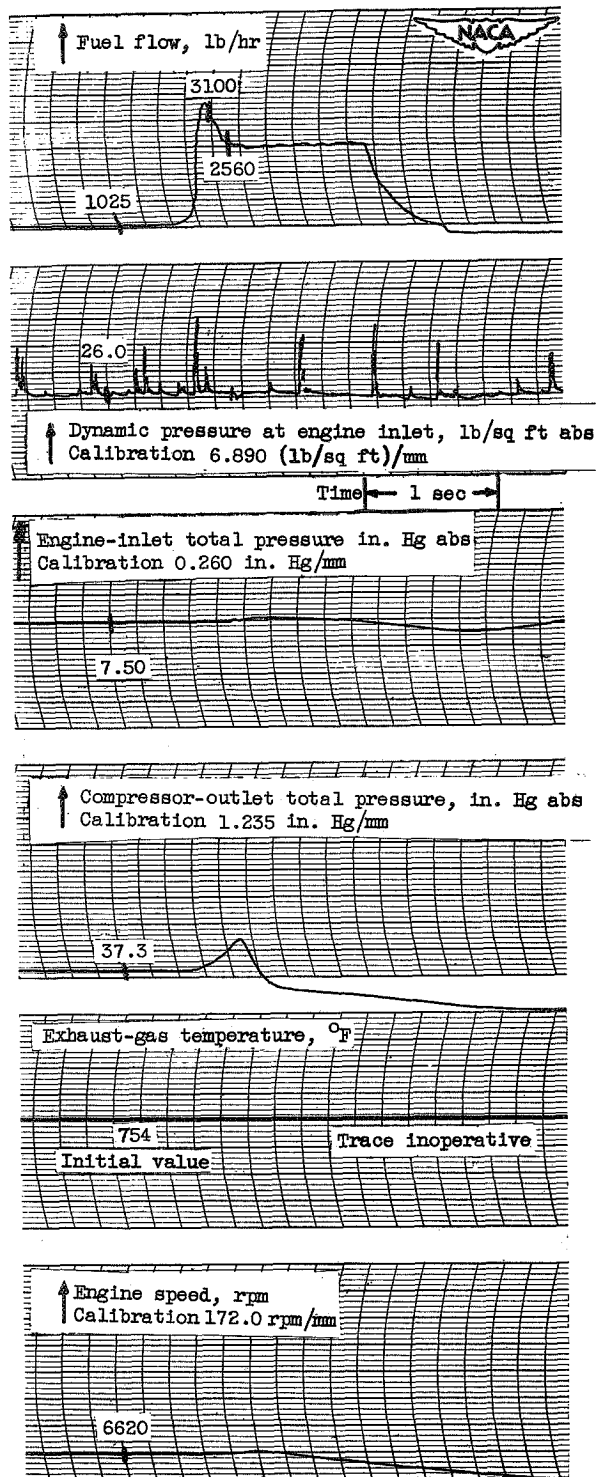


Figure 26

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 37° F; inlet guide vanes position, open.

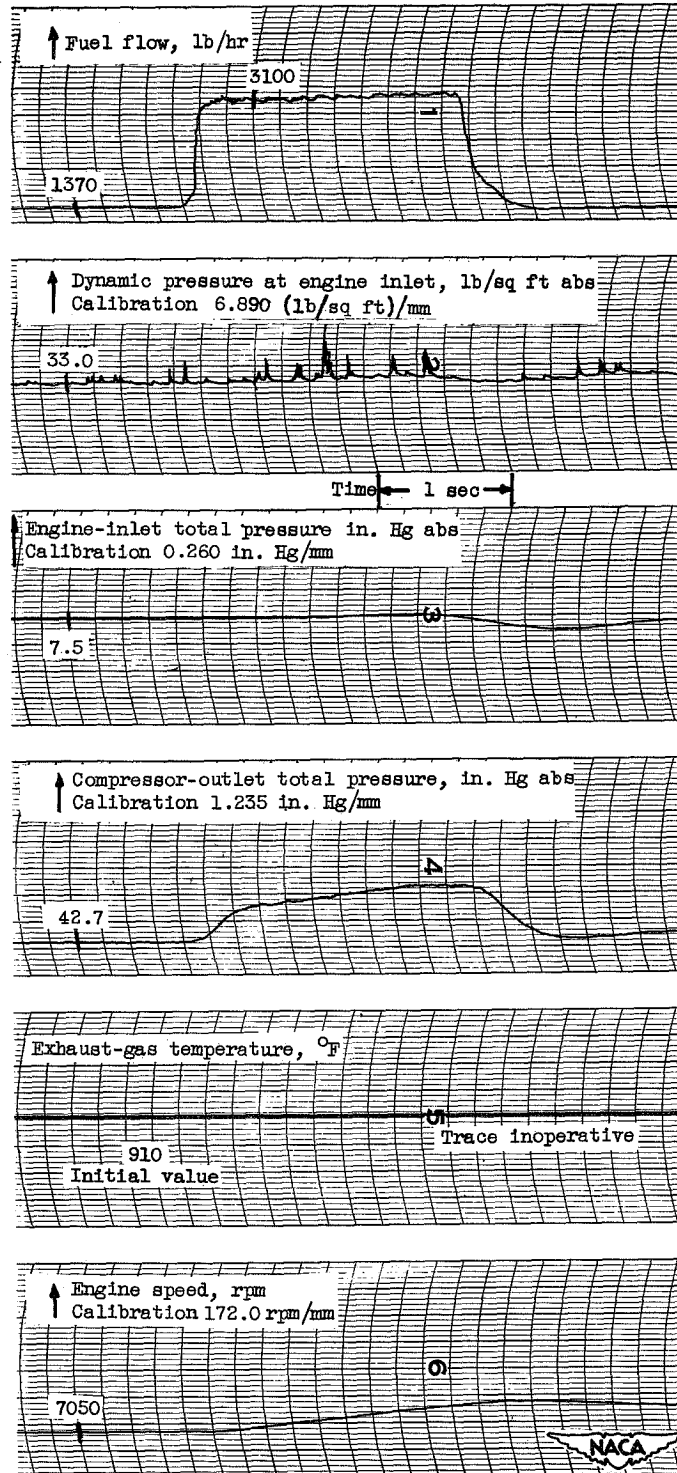


Figure 27

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 36° F; inlet guide vanes position, open.

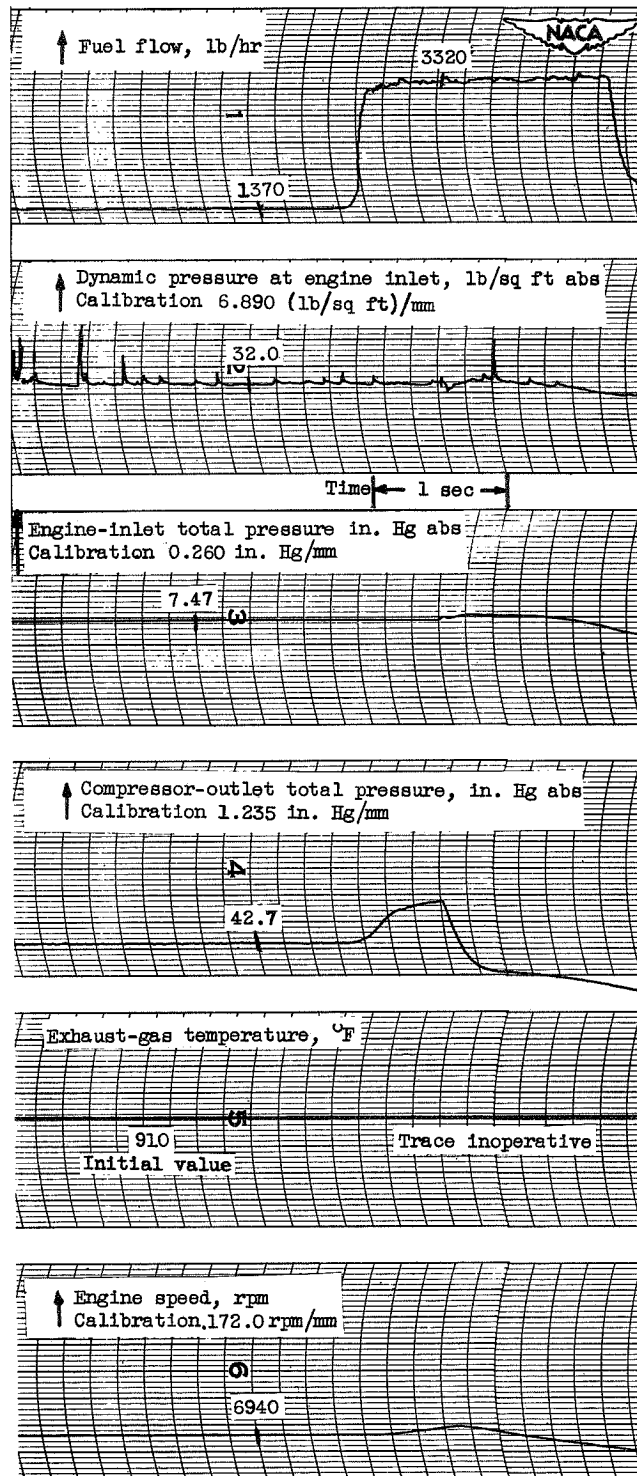


Figure 28

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 36 °F; inlet guide vanes position, open.

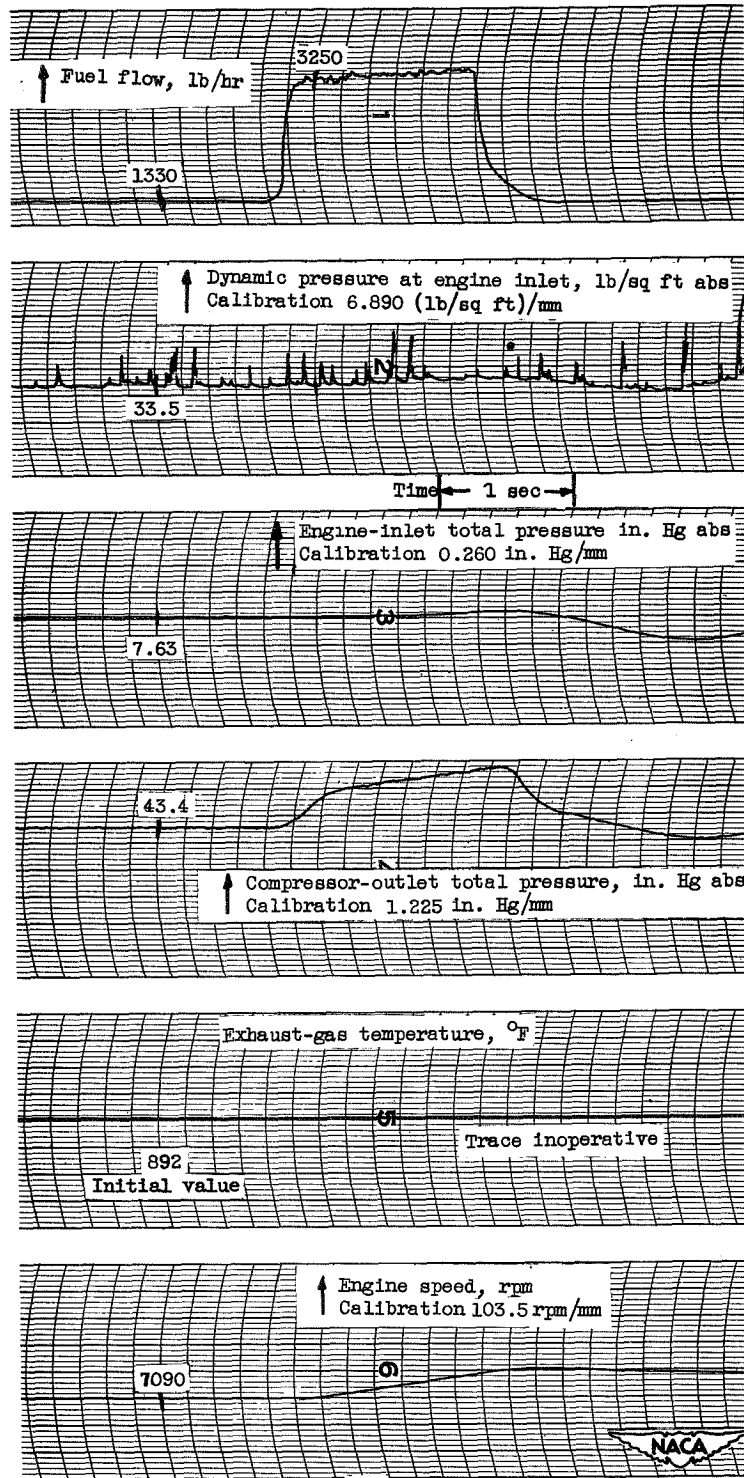


Figure 29

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 37° F; inlet guide vanes position, open.

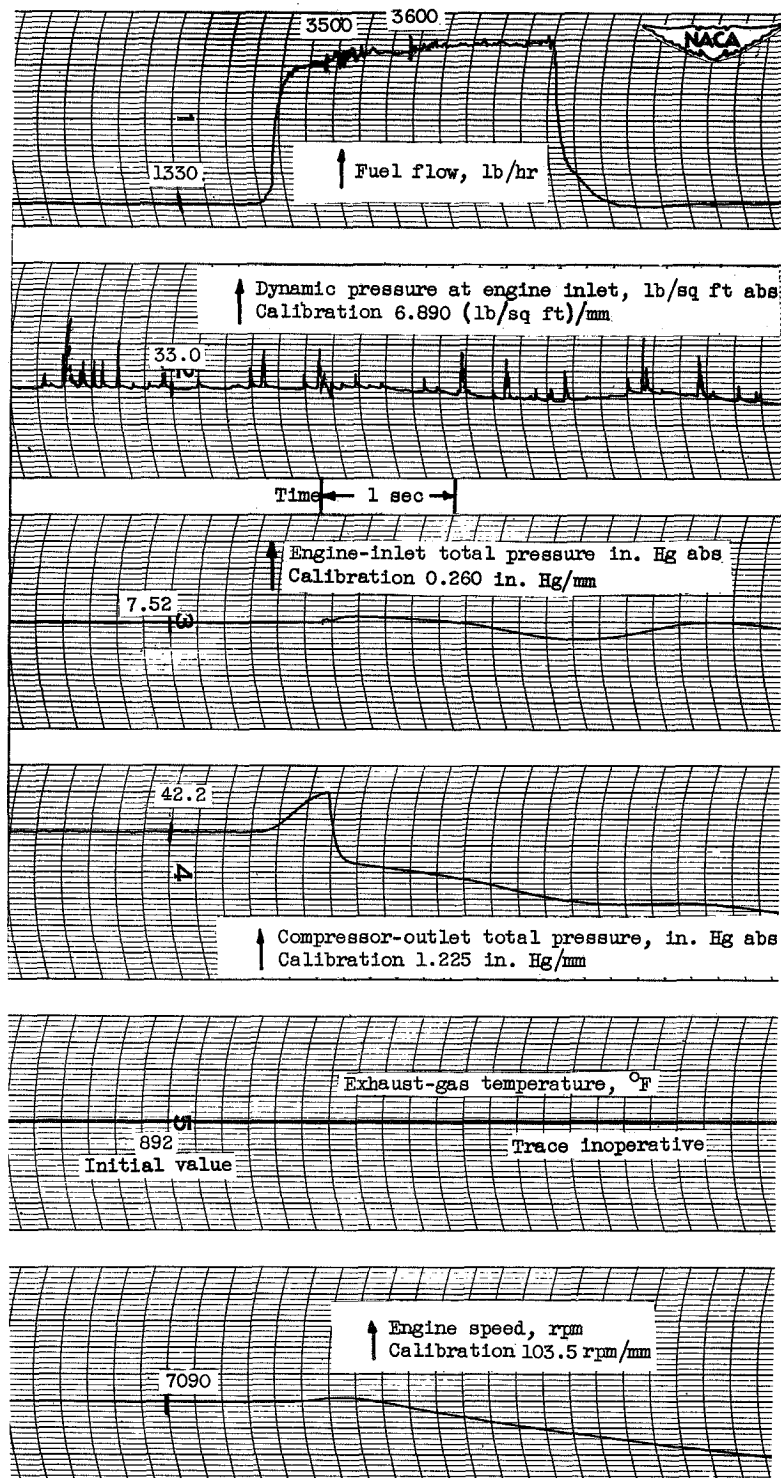


Figure 30

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 37° F; inlet guide vanes position, open.

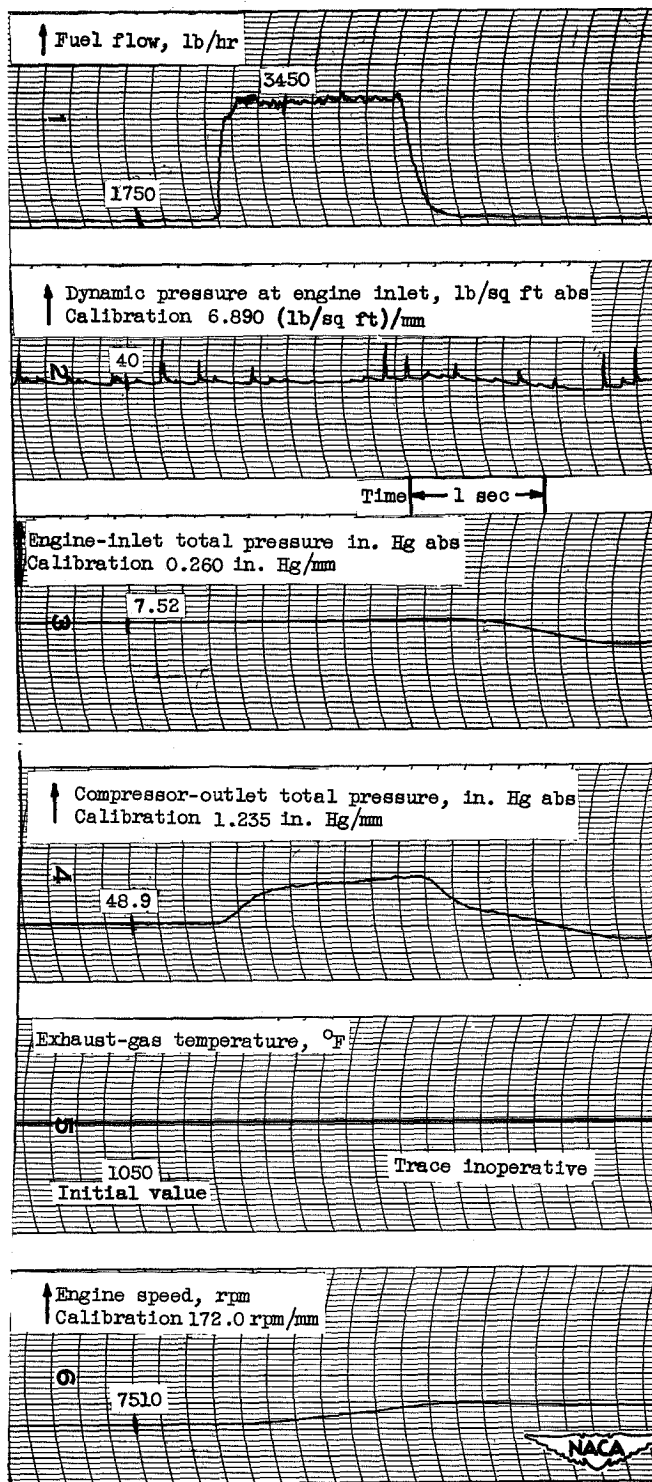


Figure 31
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 36 ° F; inlet guide vanes position, open.

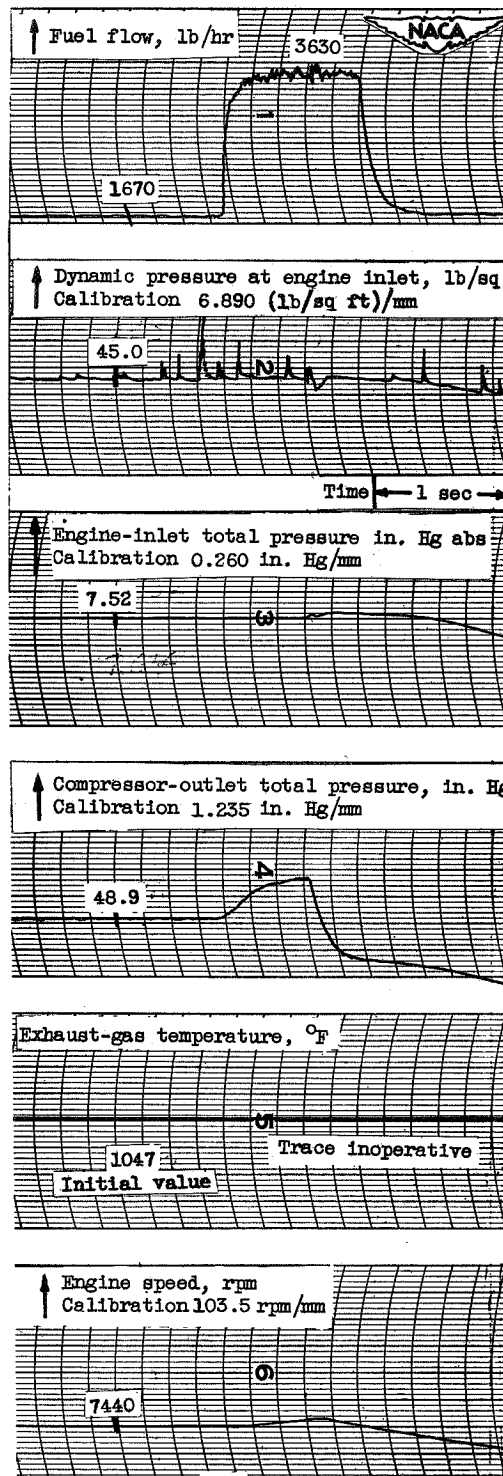


Figure 32

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 36° F; inlet guide vanes position, open.

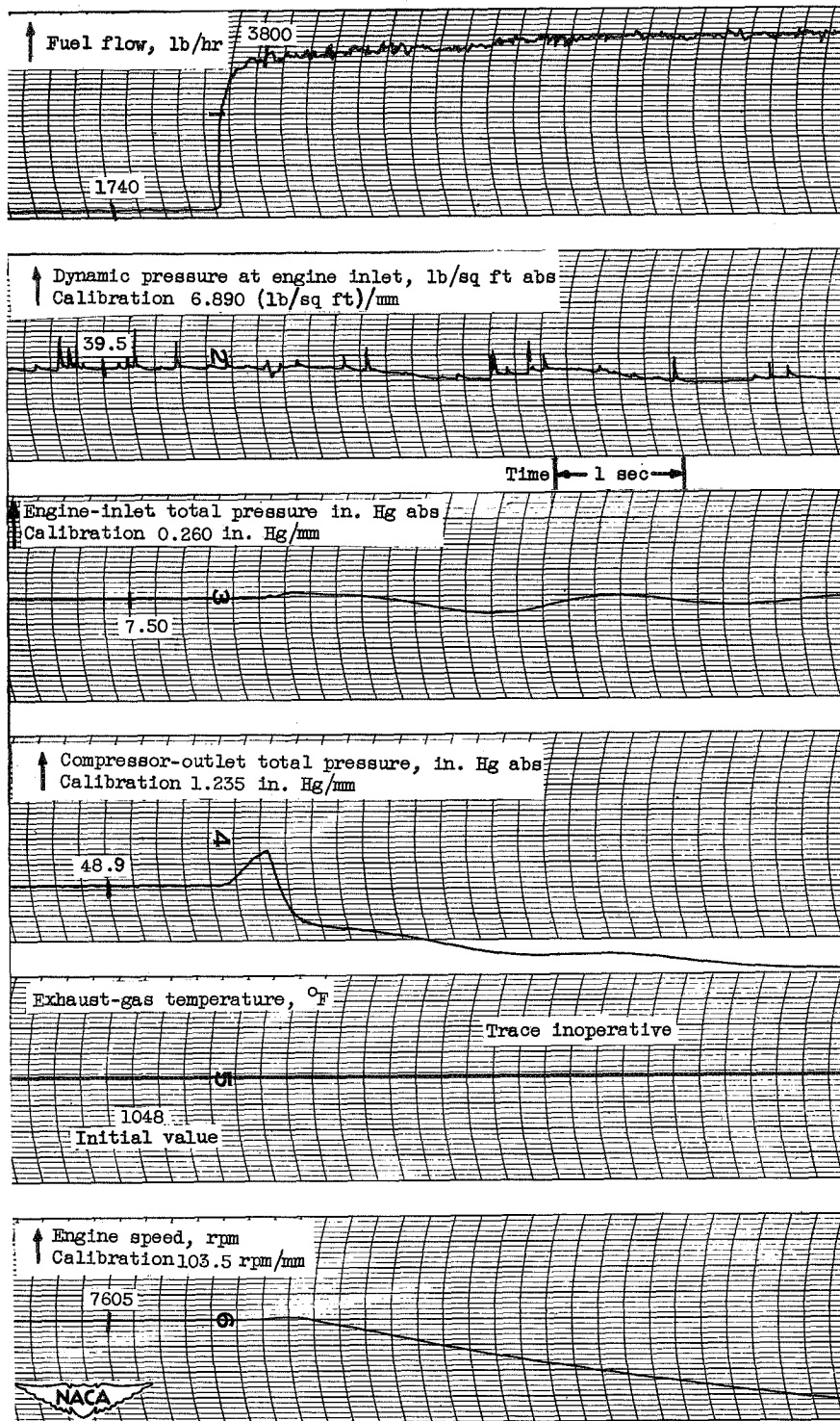


Figure 33

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 37 ° F; inlet guide vanes position, open.

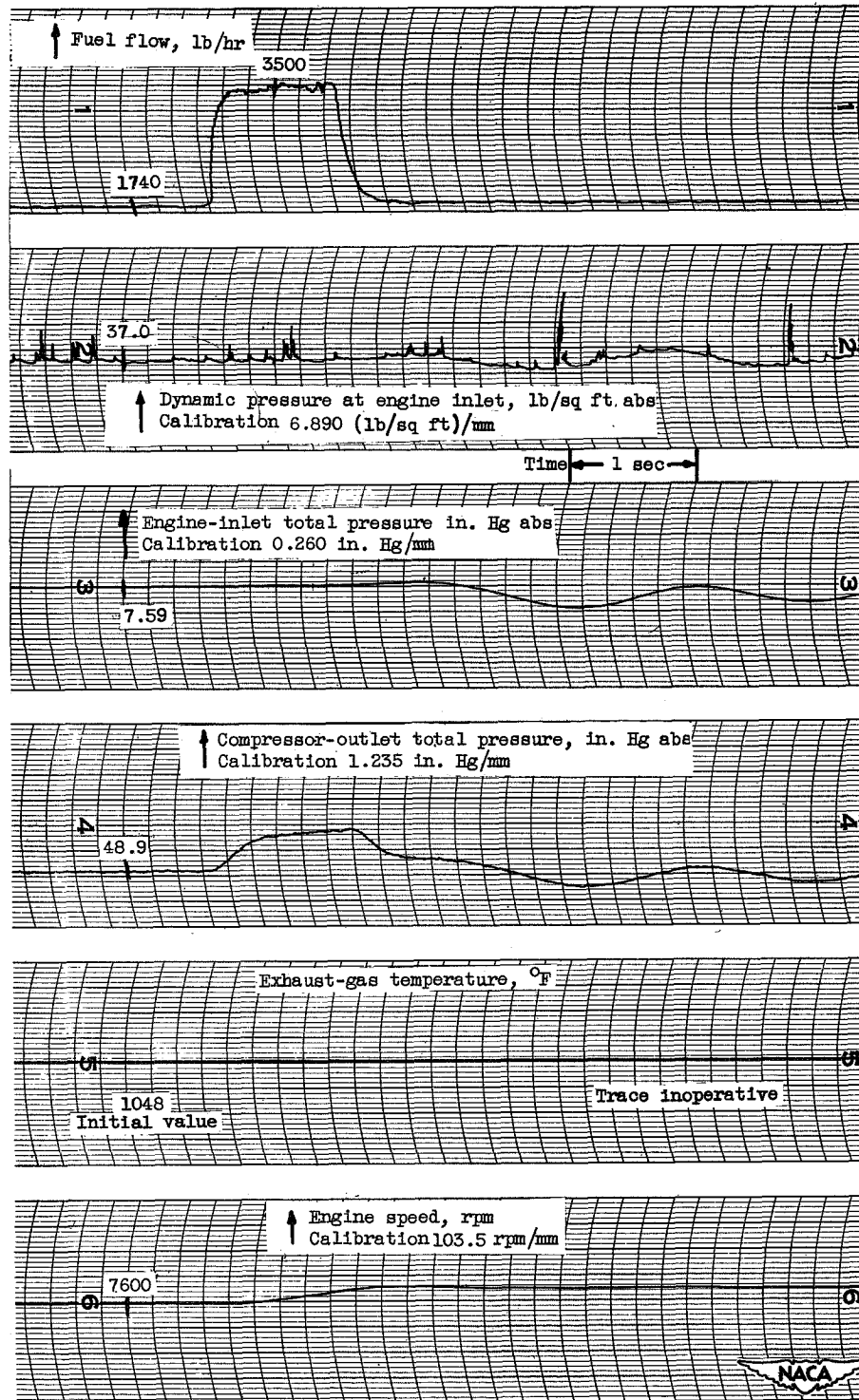


Figure 34

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 36° F; inlet guide vanes position, open.

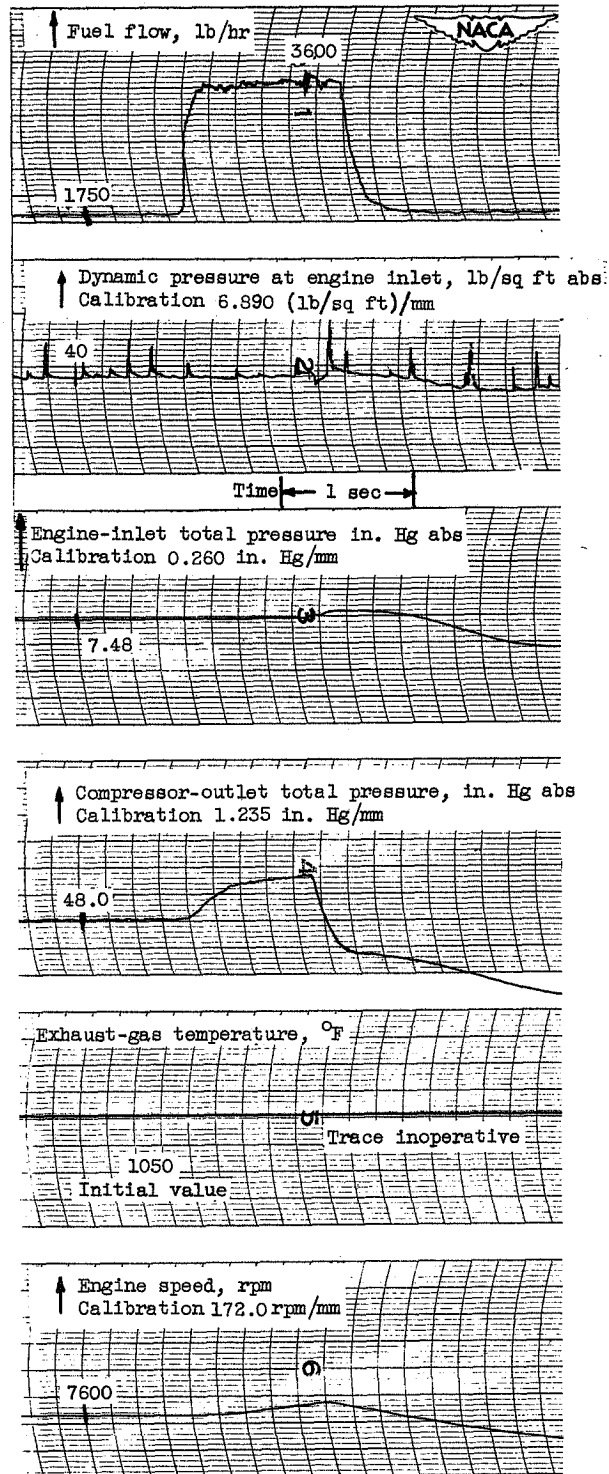


Figure 35

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, 36° F; inlet guide vanes position, open.

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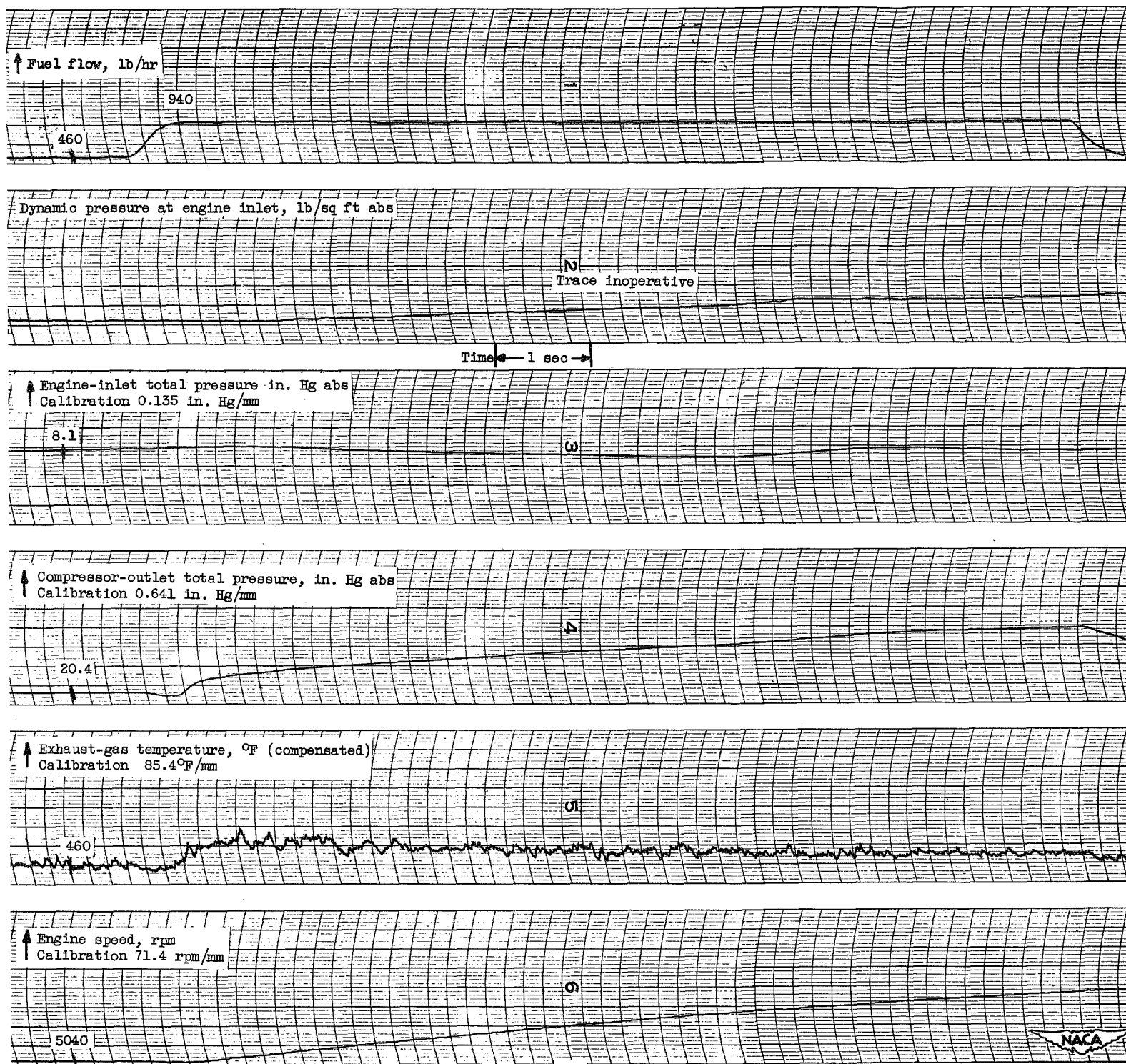


Figure 36
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, -6° F; inlet guide vanes position, closed.

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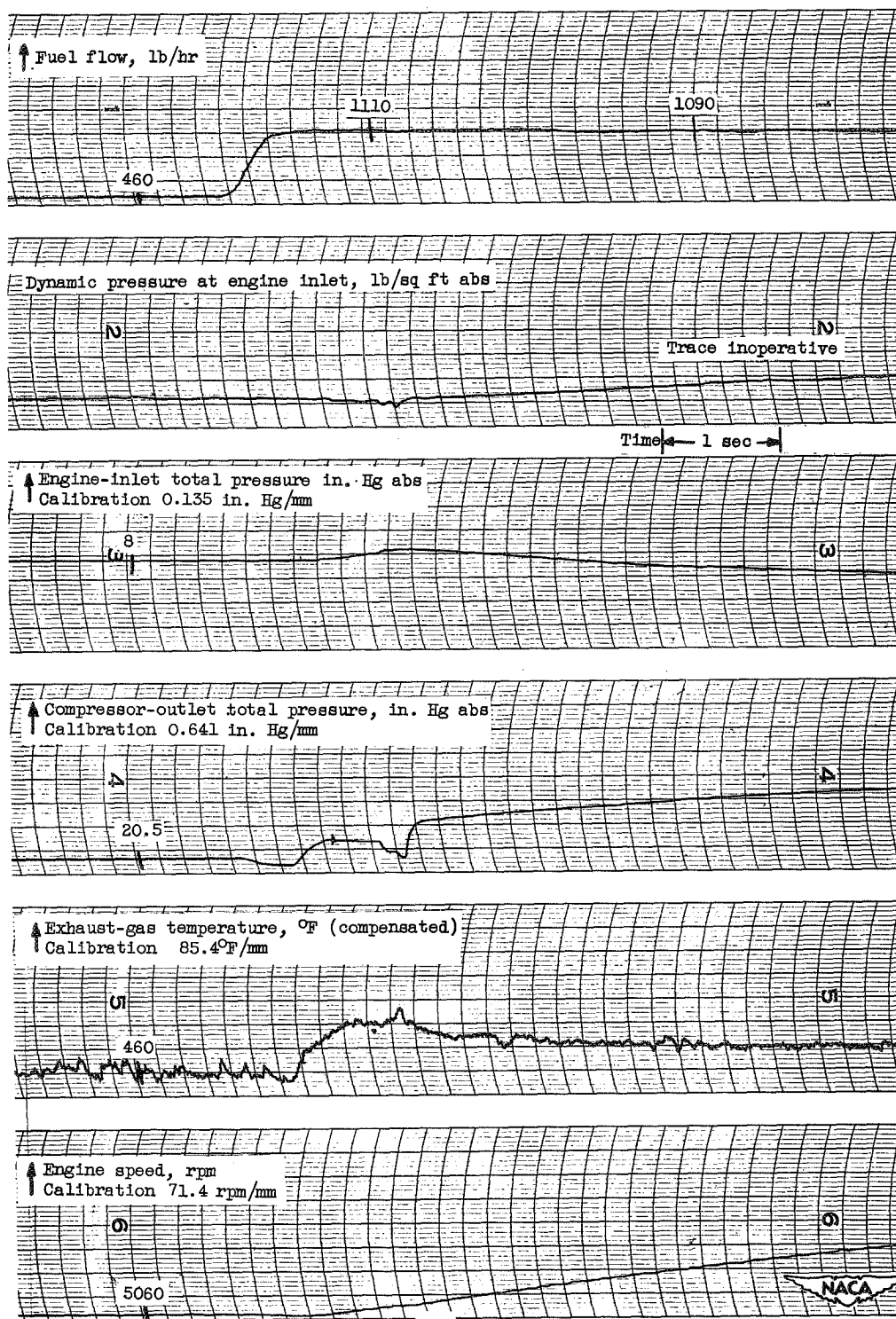


Figure 37

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, -6 °F; inlet guide vanes position, closed.

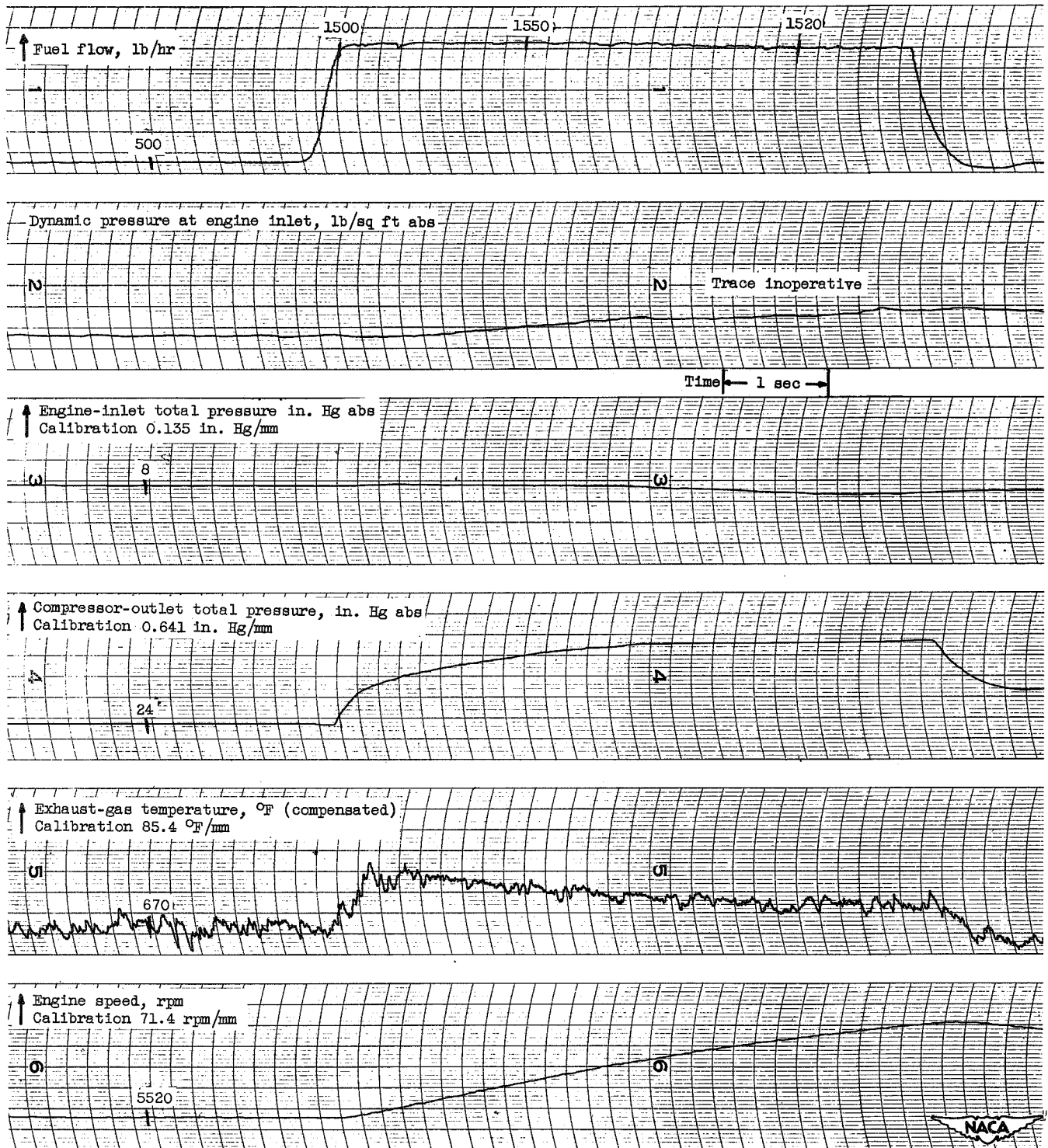


Figure 38

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, -5°F ; inlet guide vanes position, closed.

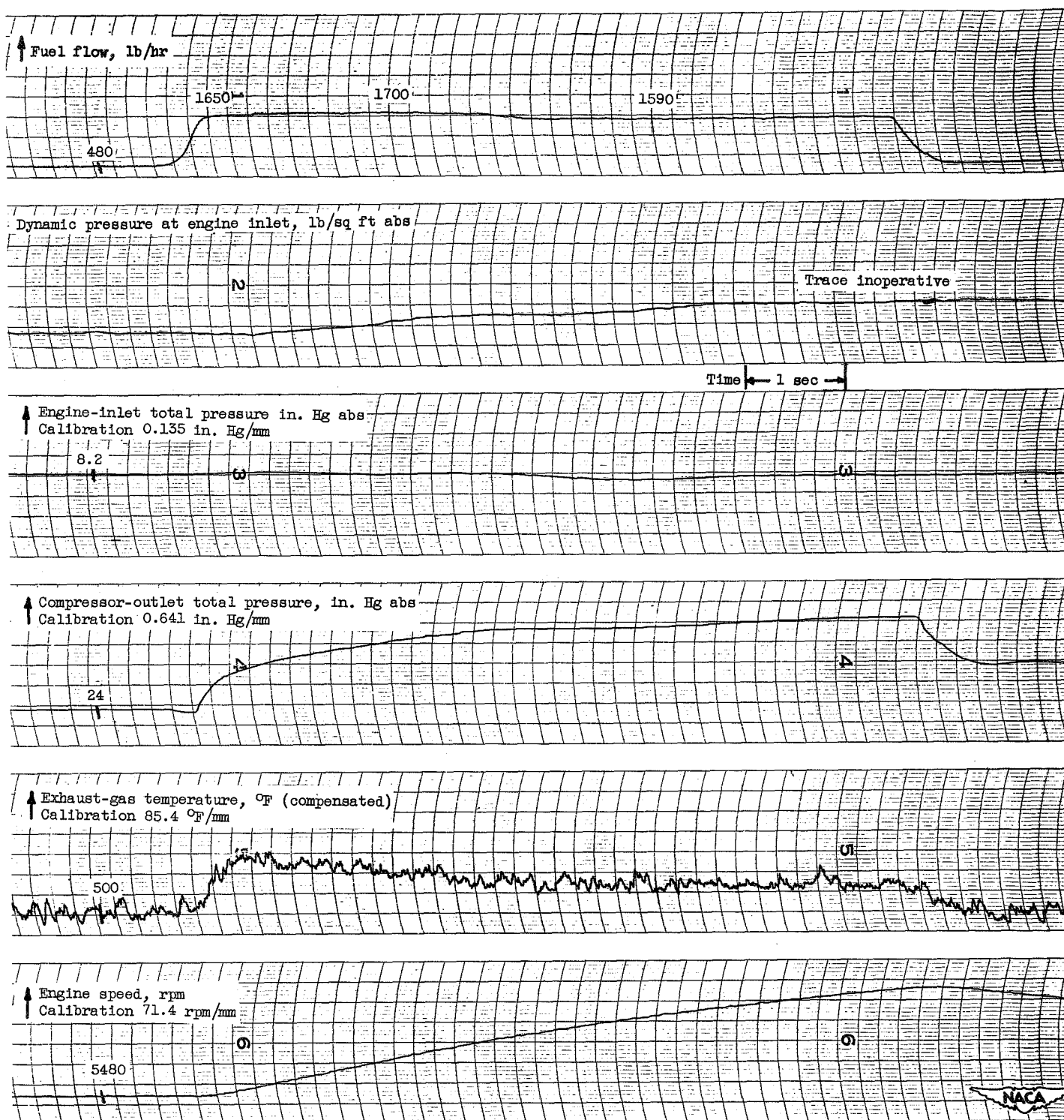


Figure 39

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, -3°F ; inlet guide vanes position, closed.

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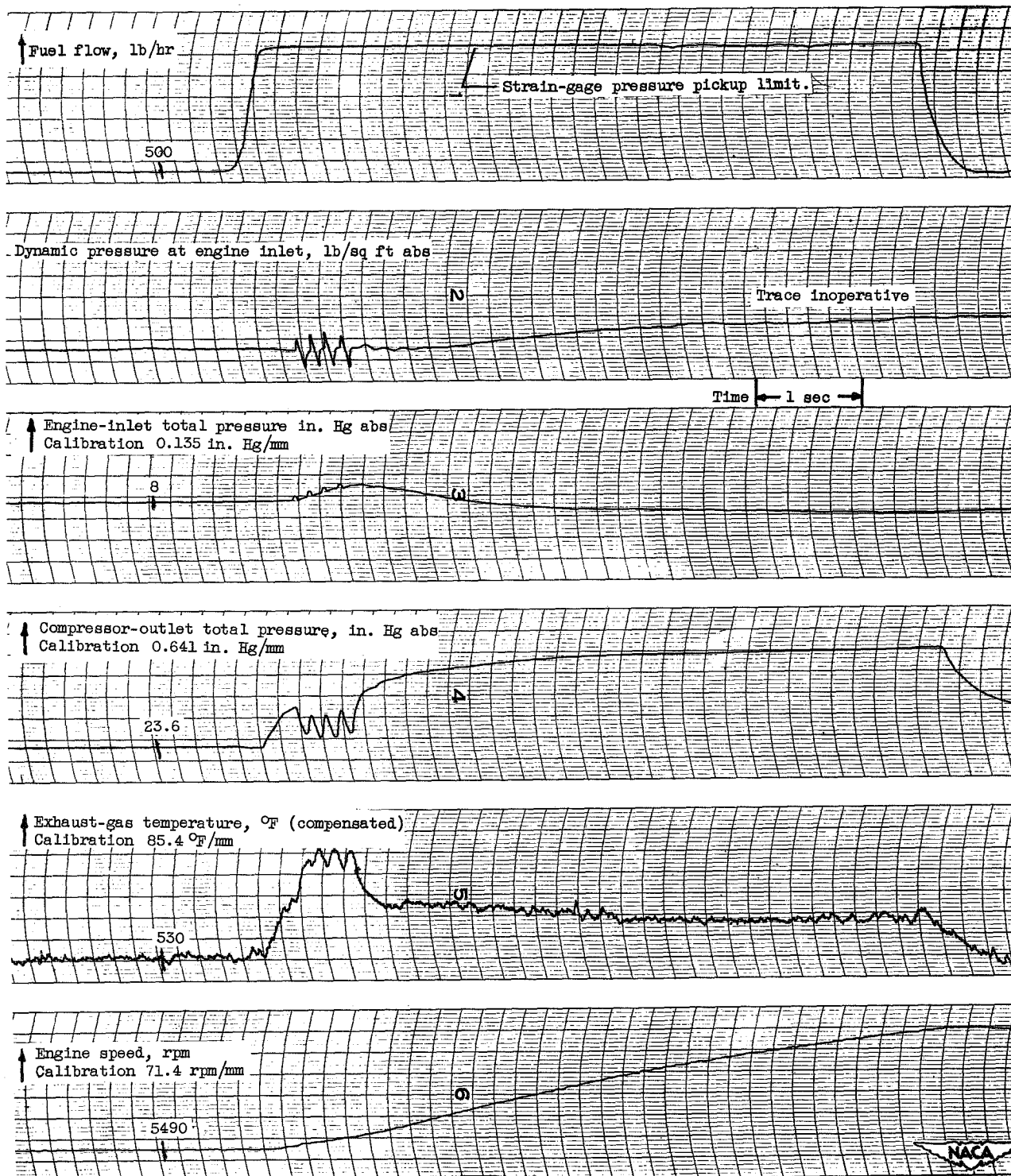


Figure 40

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, -5° F; inlet guide vanes position, closed.

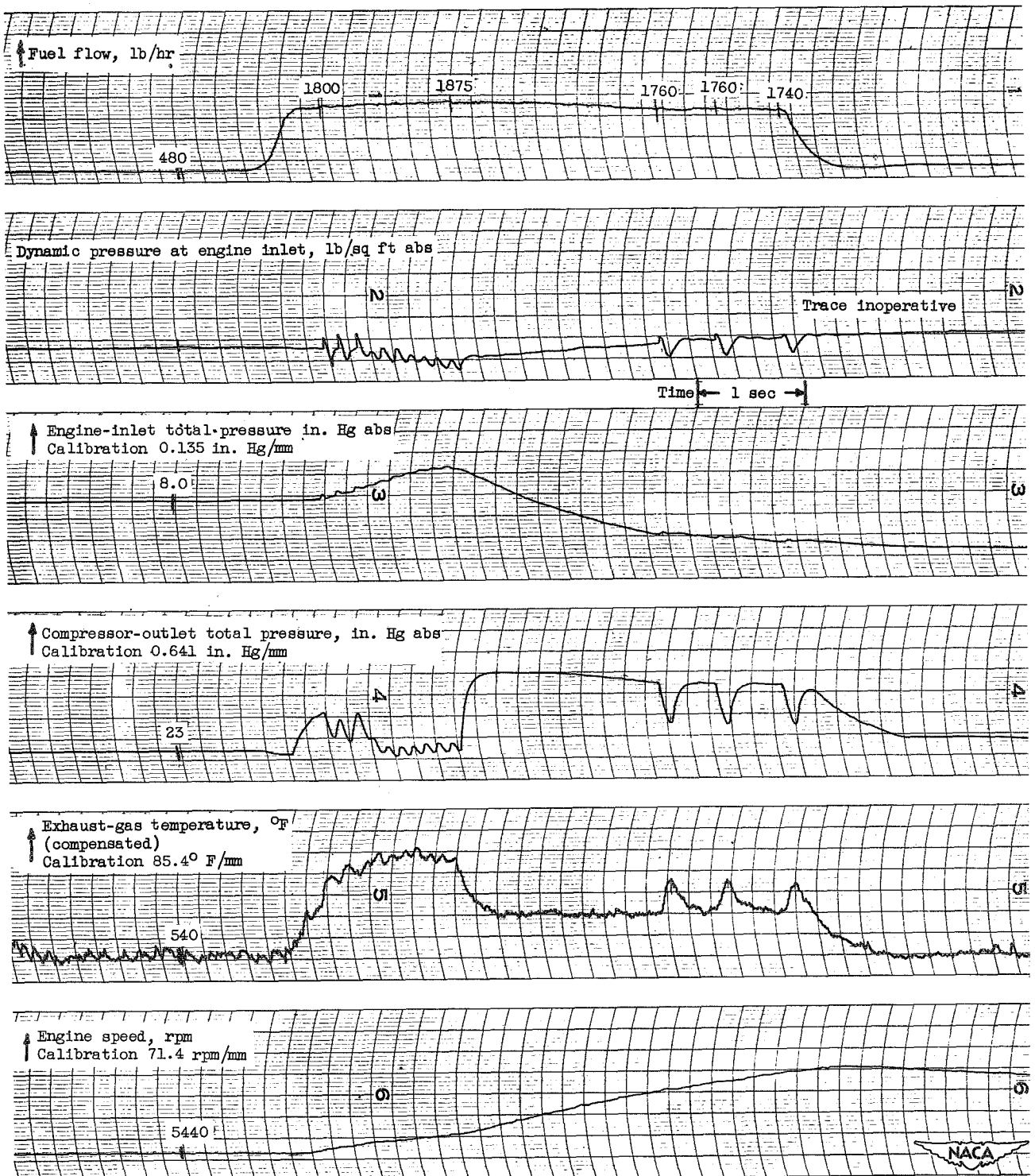


Figure 41

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000feet; flight Mach number, 0.3; engine-inlet air temperature, -3 ° F; inlet guide vanes position, closed.

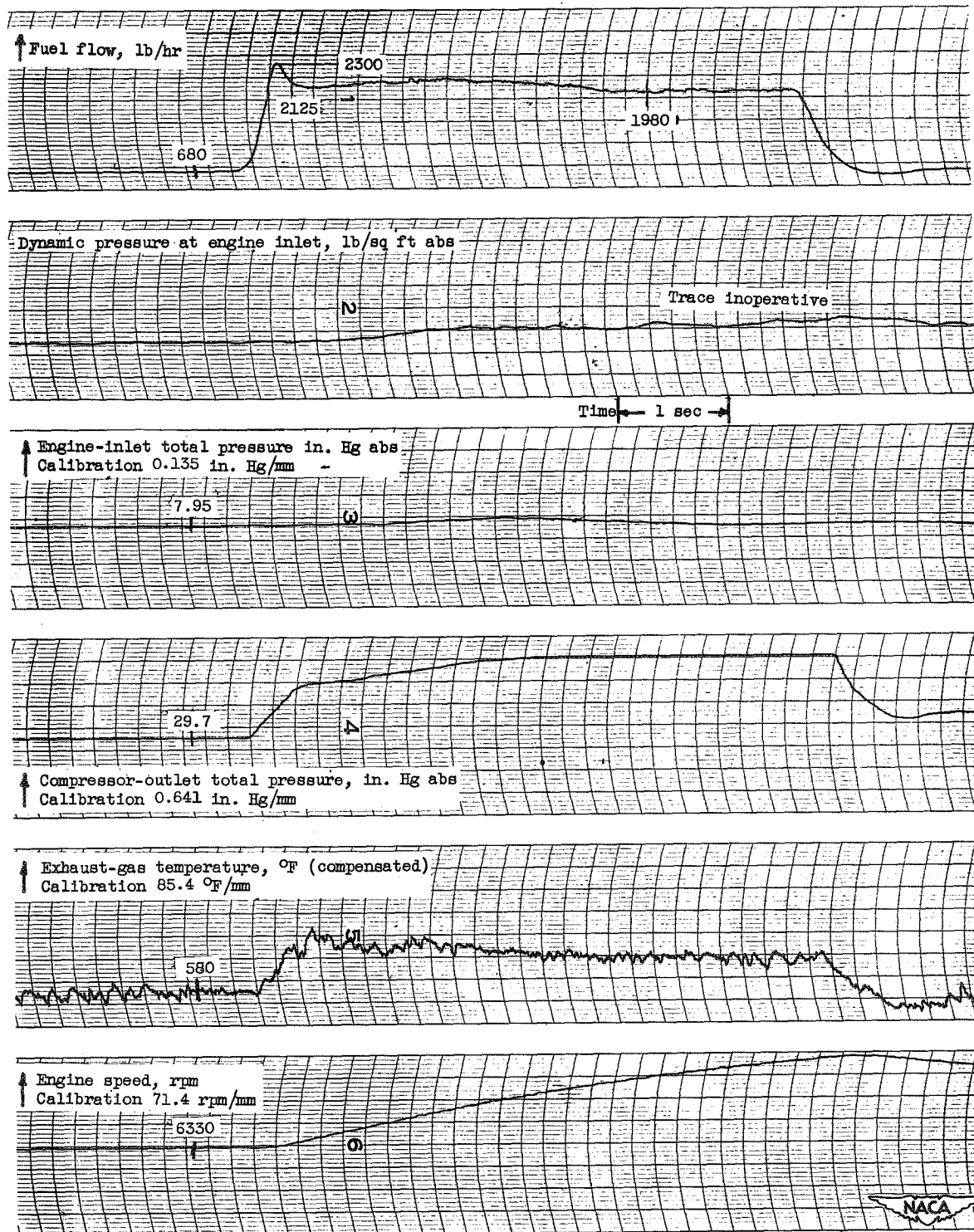


Figure 42
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, -1°F ; inlet guide vanes position, closed.

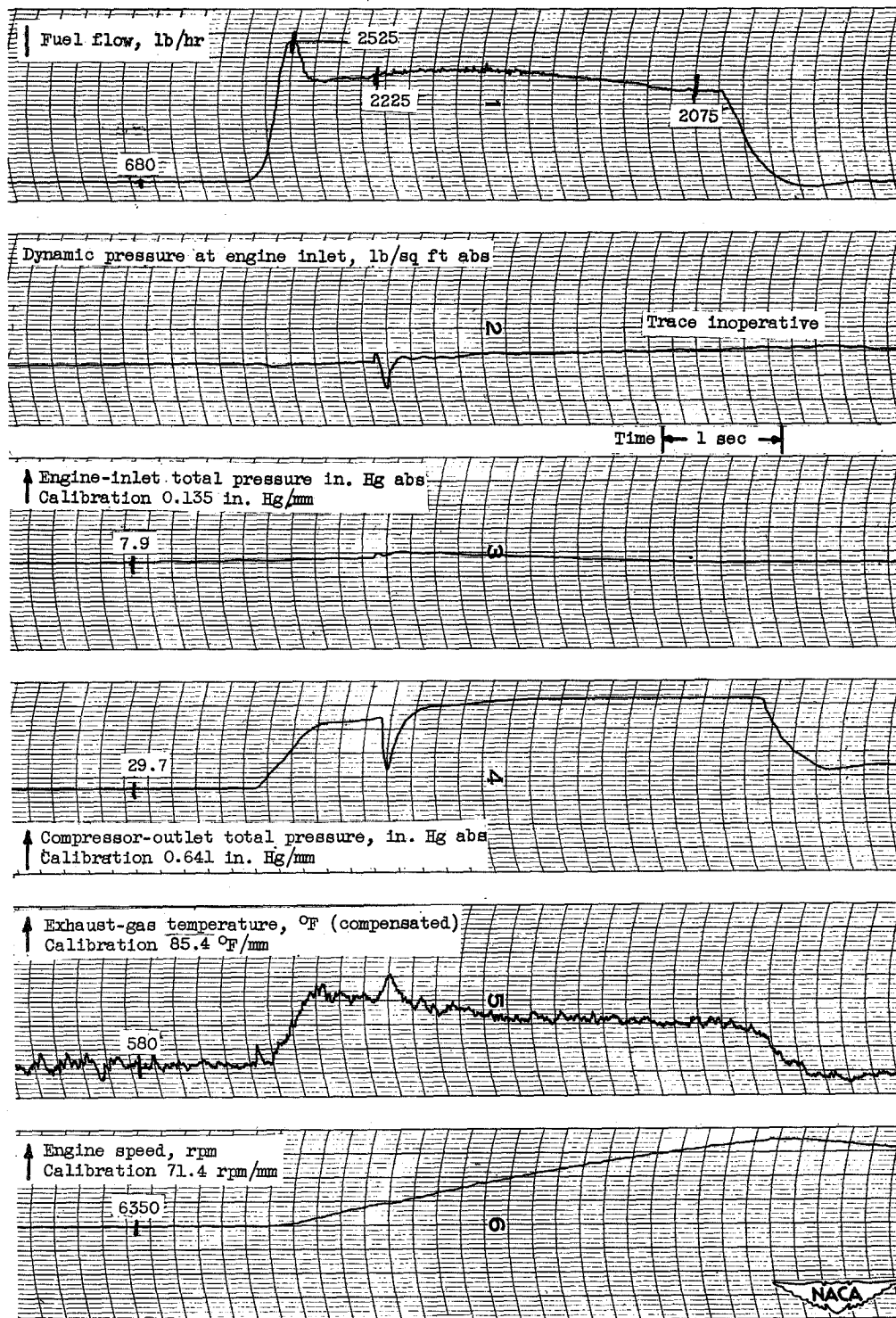


Figure 43

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, -1°F ; inlet guide vanes position, closed.

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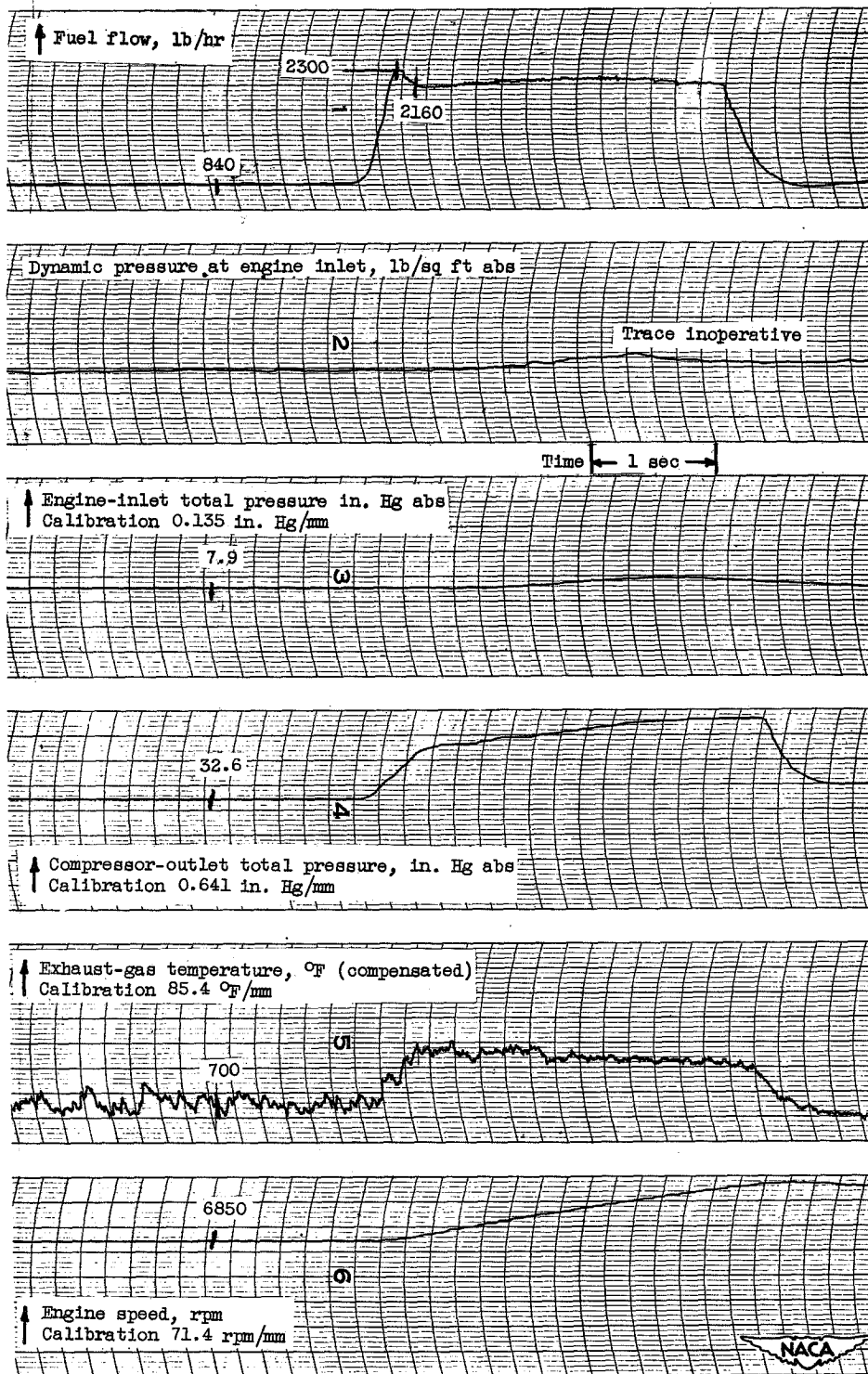


Figure 44
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, -2 ° F; inlet guide vanes position, closed.

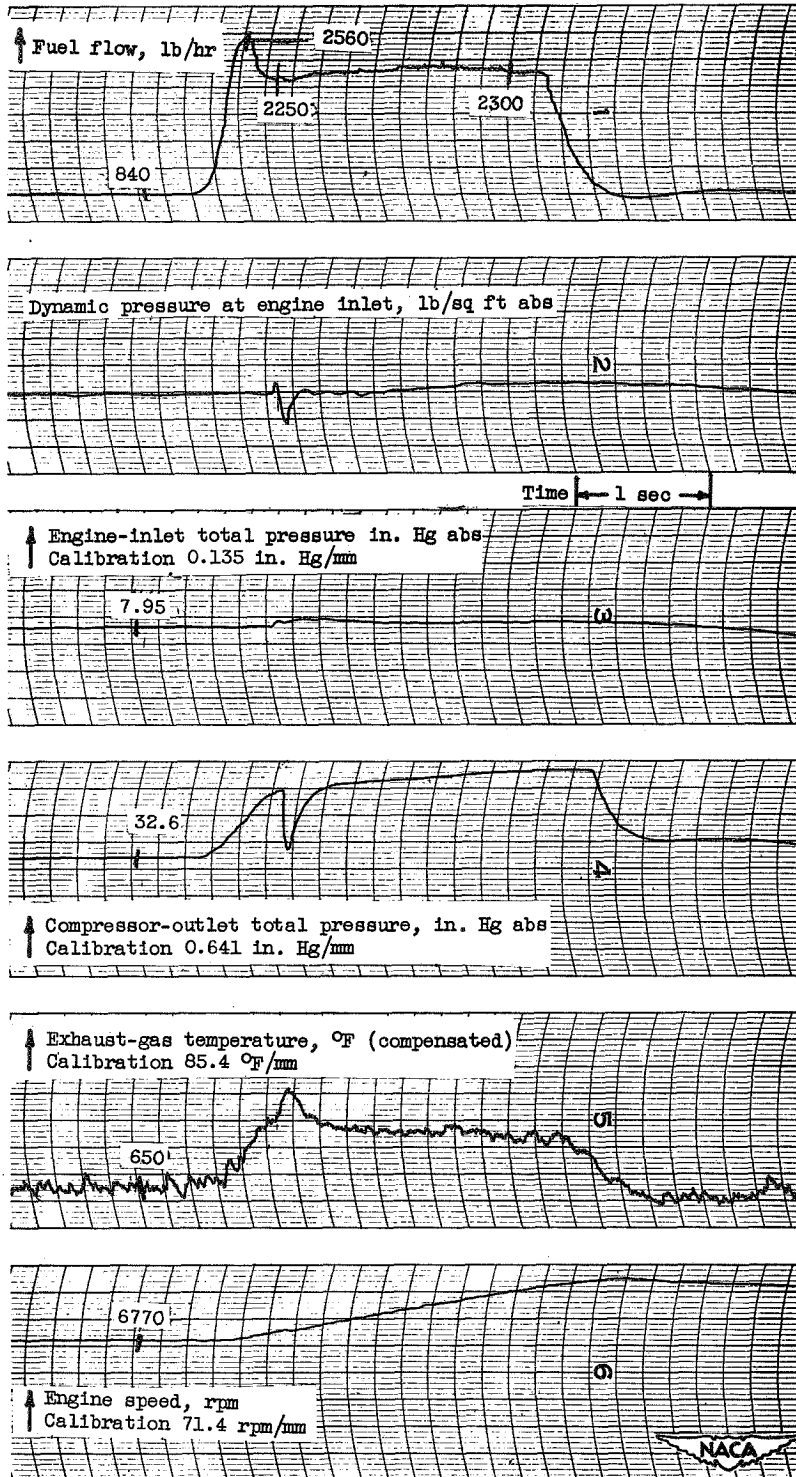


Figure 45

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.3; engine-inlet air temperature, -2° F; inlet guide vanes position, closed.

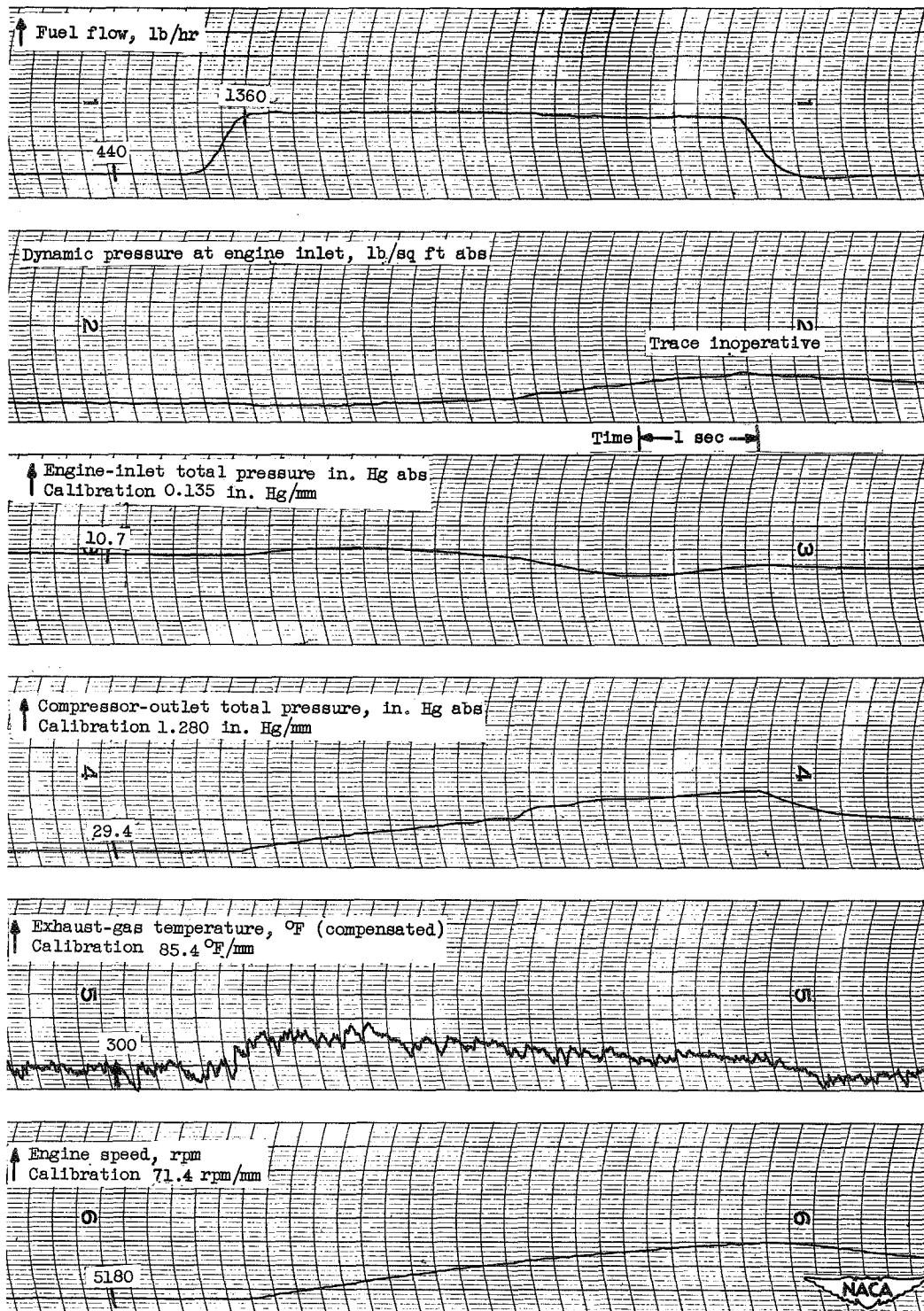


Figure 46
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -10° F; inlet guide vanes position, open.

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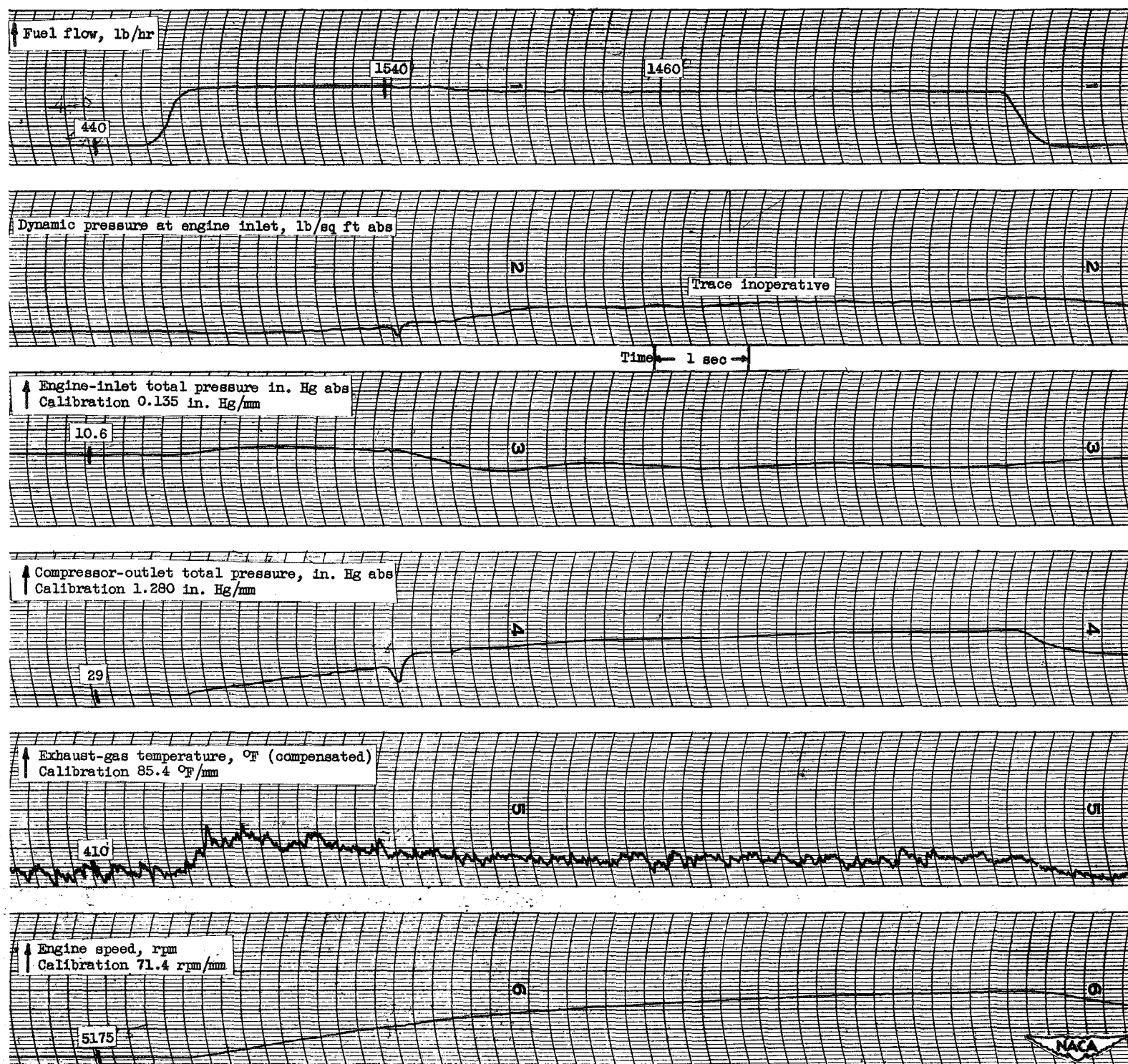


Figure 47
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -10°F ; inlet-guide vanes position, open.

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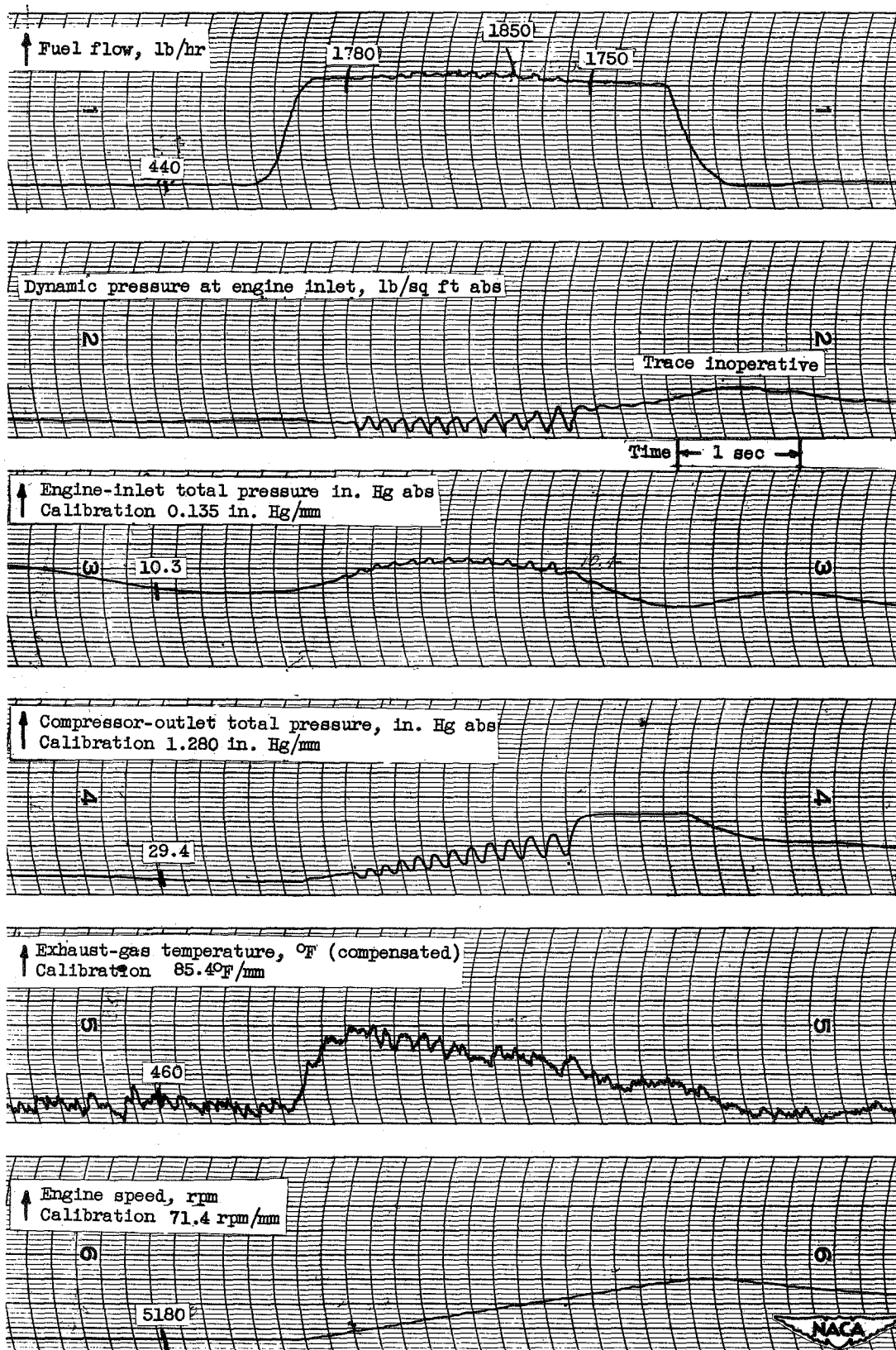


Figure 48

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -10° F; inlet guide vanes position, open.

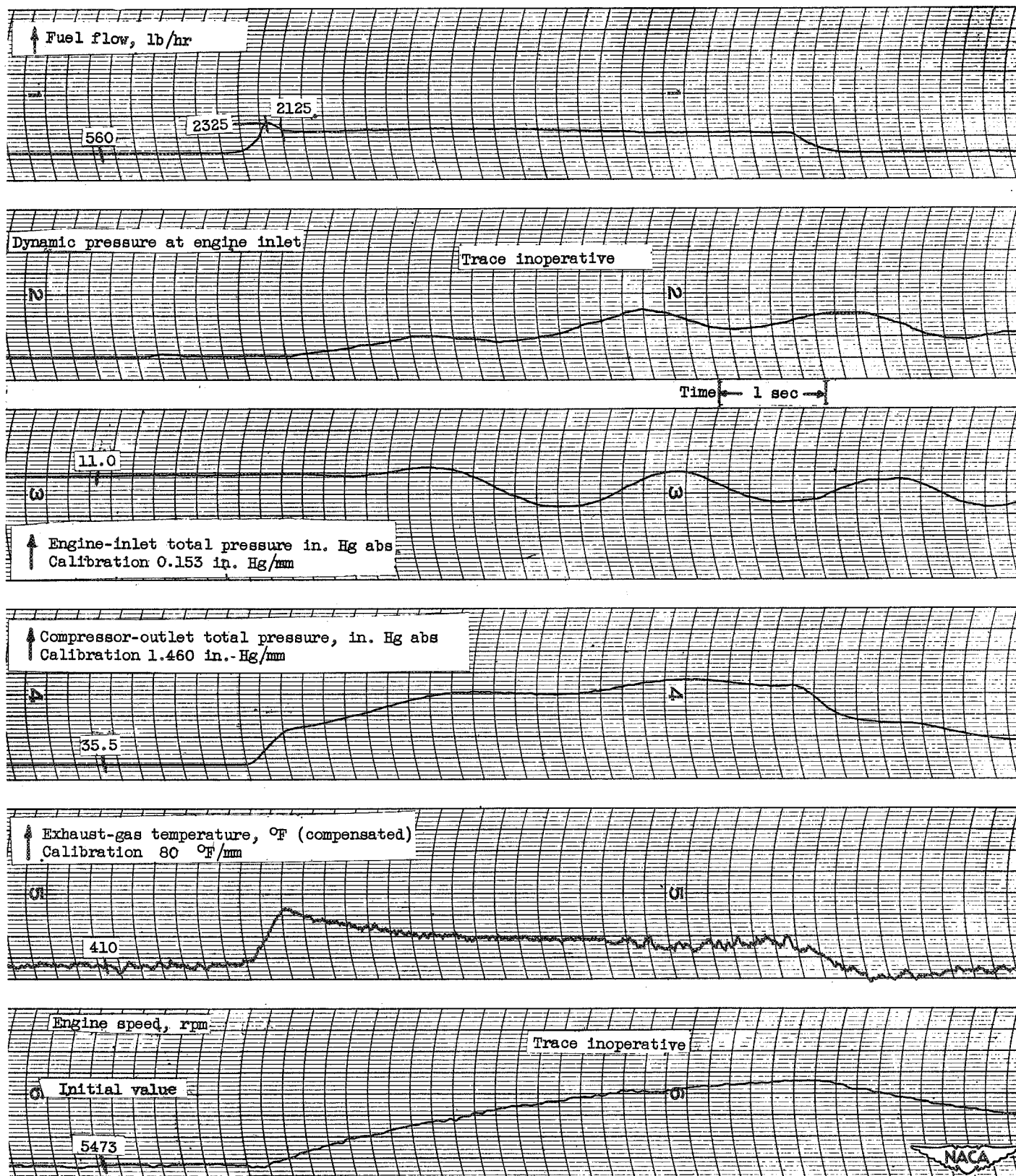


Figure 49

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -8°F ; inlet guide vanes position, open.

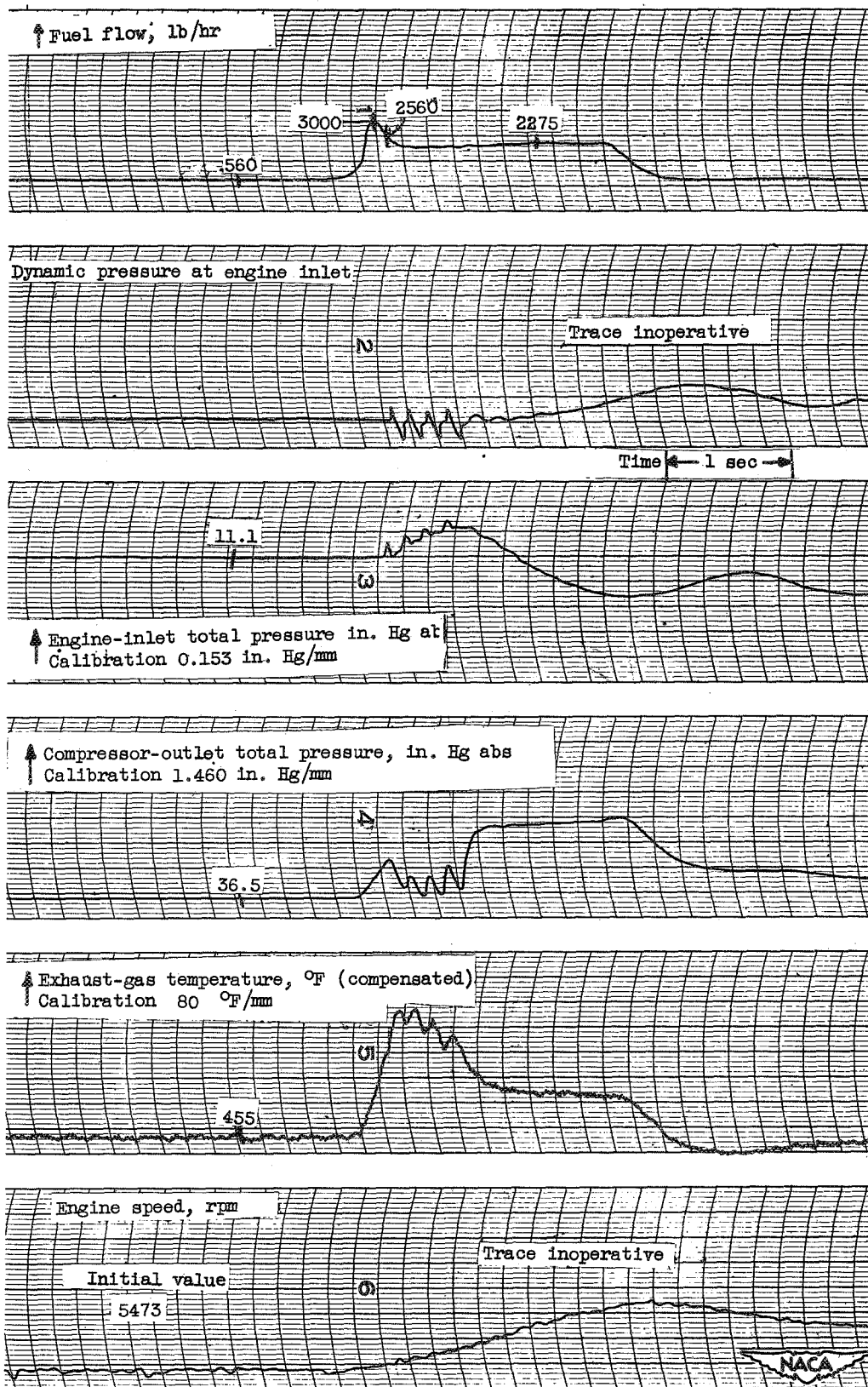


Figure 50

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -8° F; inlet guide vanes position, open.

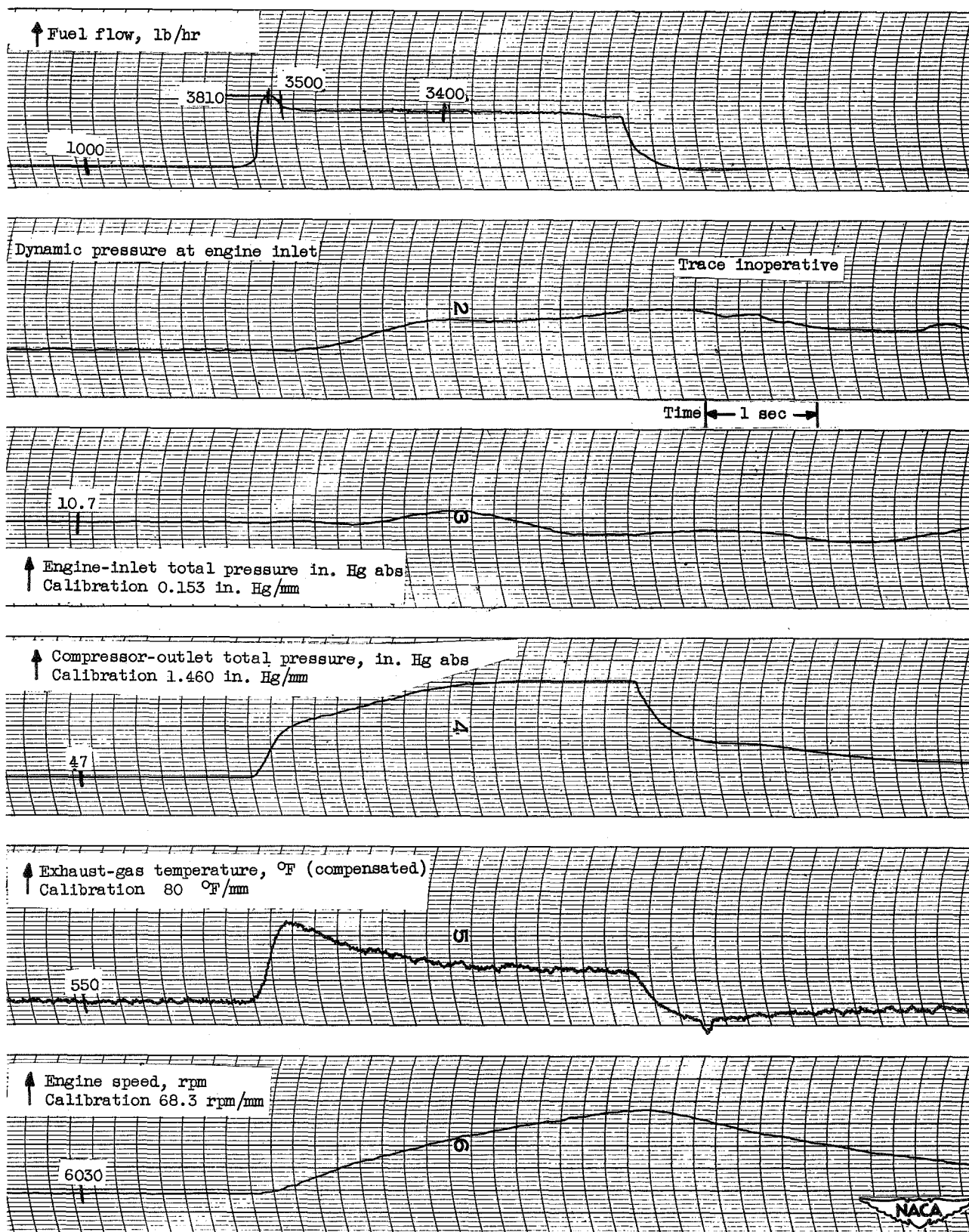


Figure 51

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -6°F ; inlet guide vanes position, open.

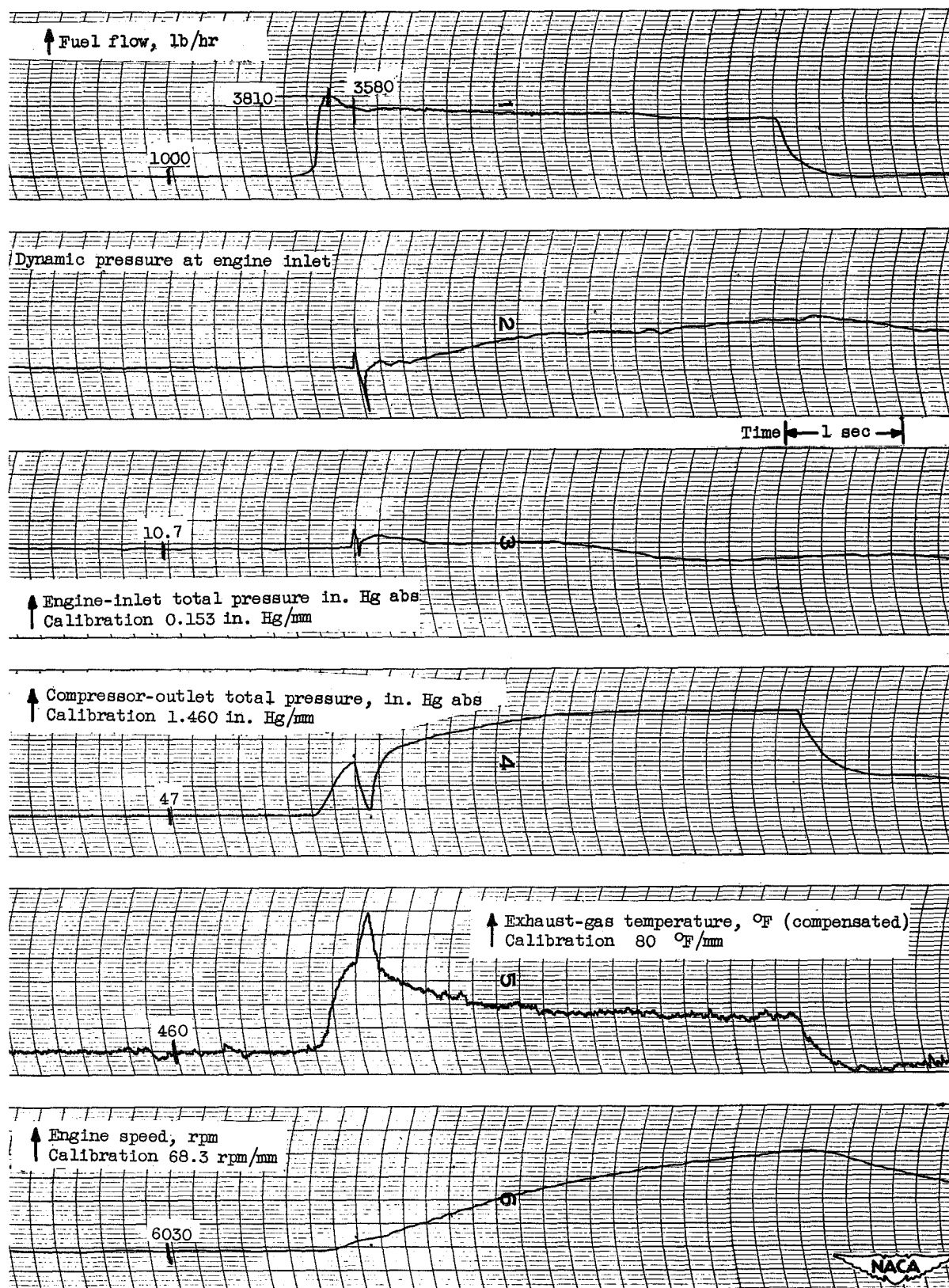


Figure 52

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -6°F ; inlet guide vanes position, open.

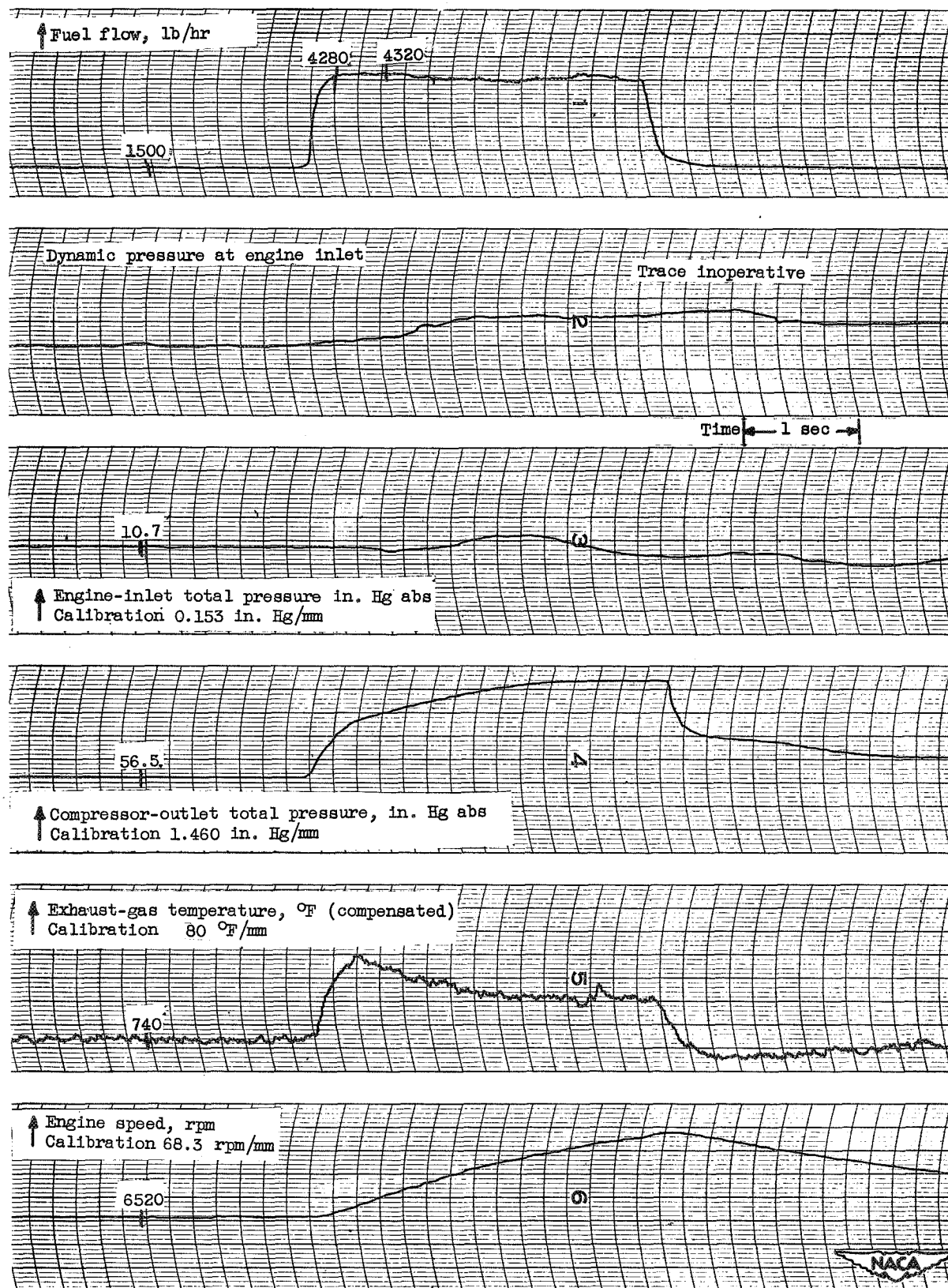


Figure 53

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -6°F ; inlet guide vanes position, open.

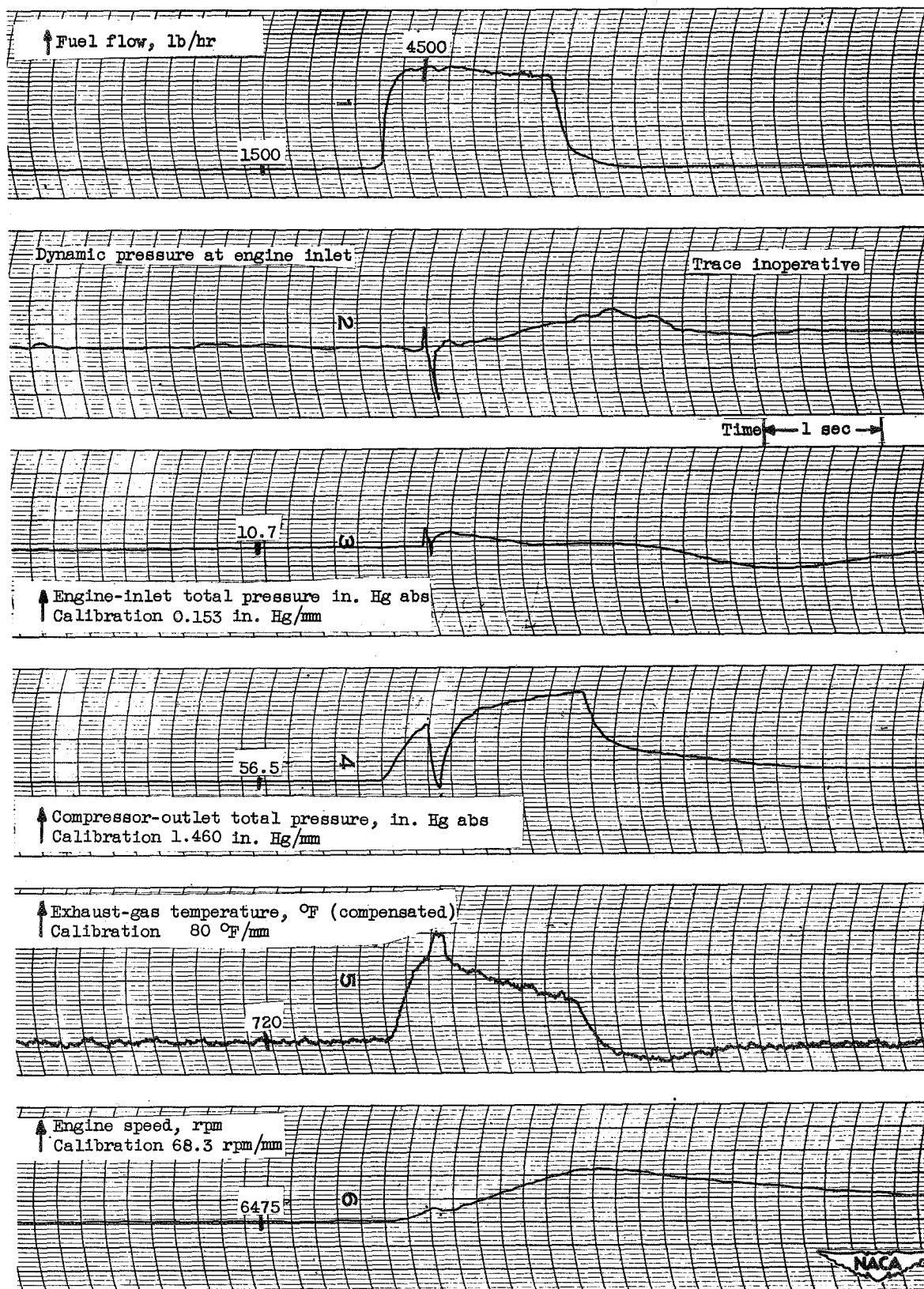


Figure 54

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -6°F ; inlet guide vanes position, open.

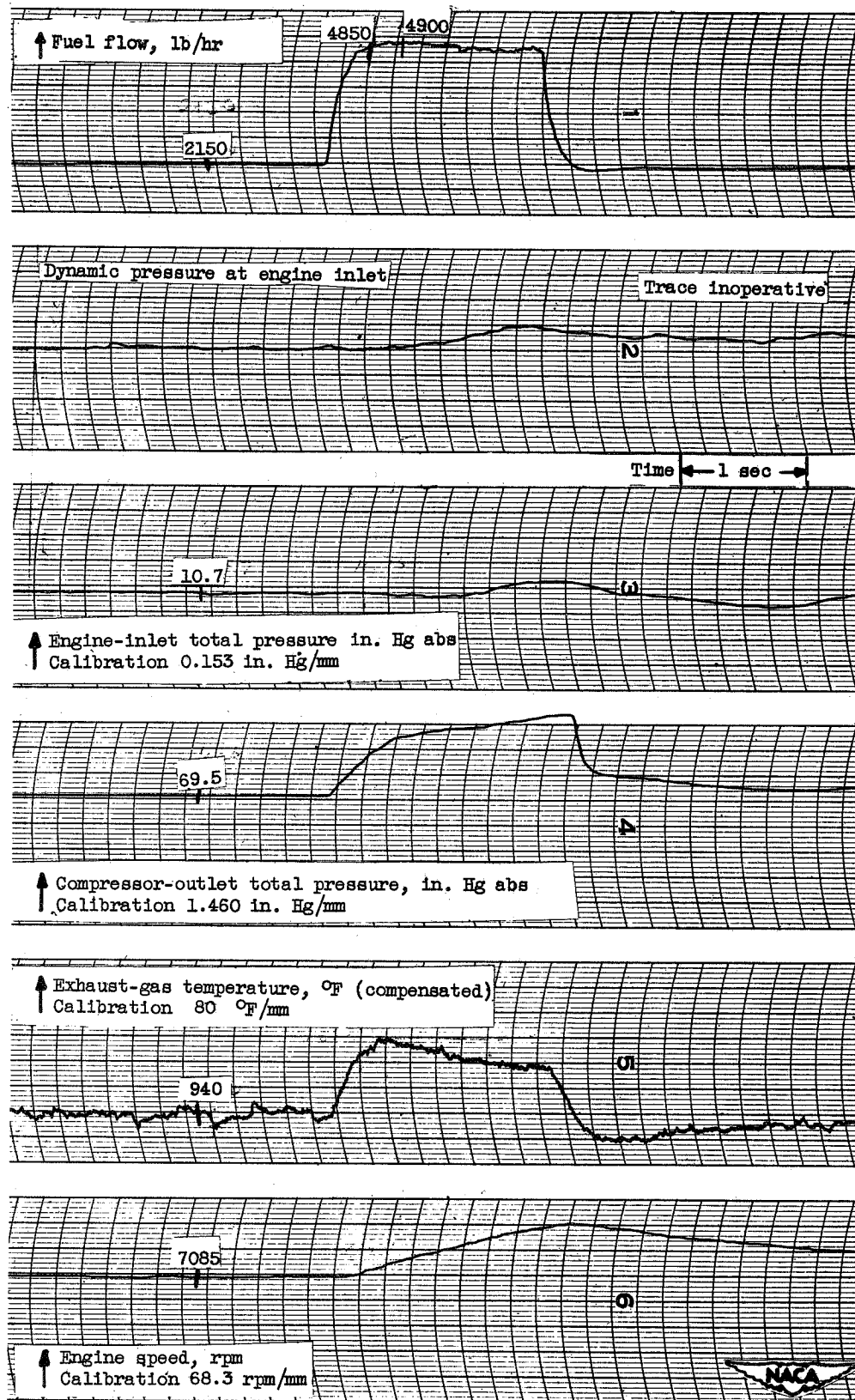


Figure 55

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -8°F ; inlet guide vanes position, open.

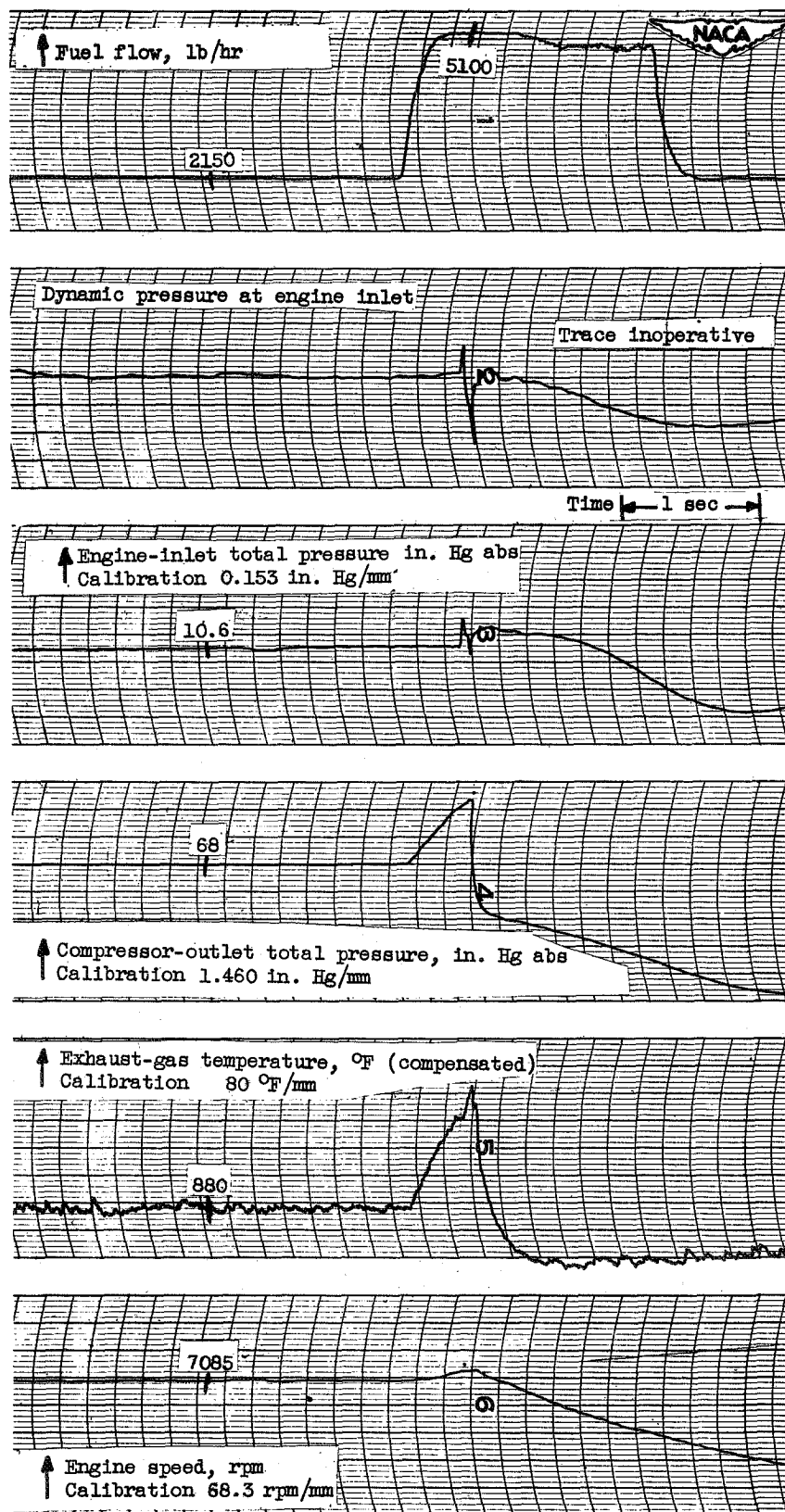


Figure 56

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -8°F ; inlet guide vanes position, open.

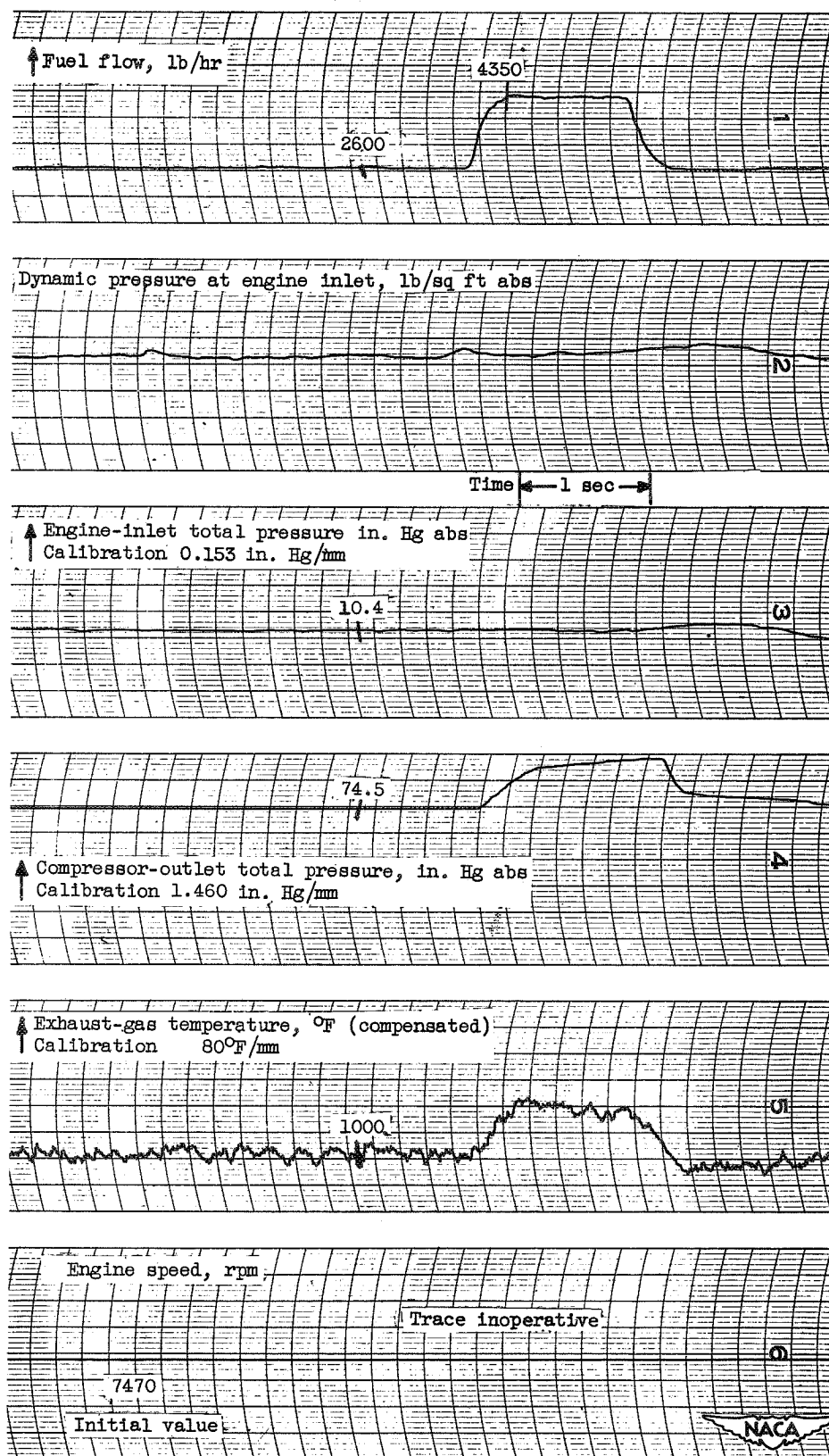


Figure 57

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -9°F ; inlet guide vanes position, open.

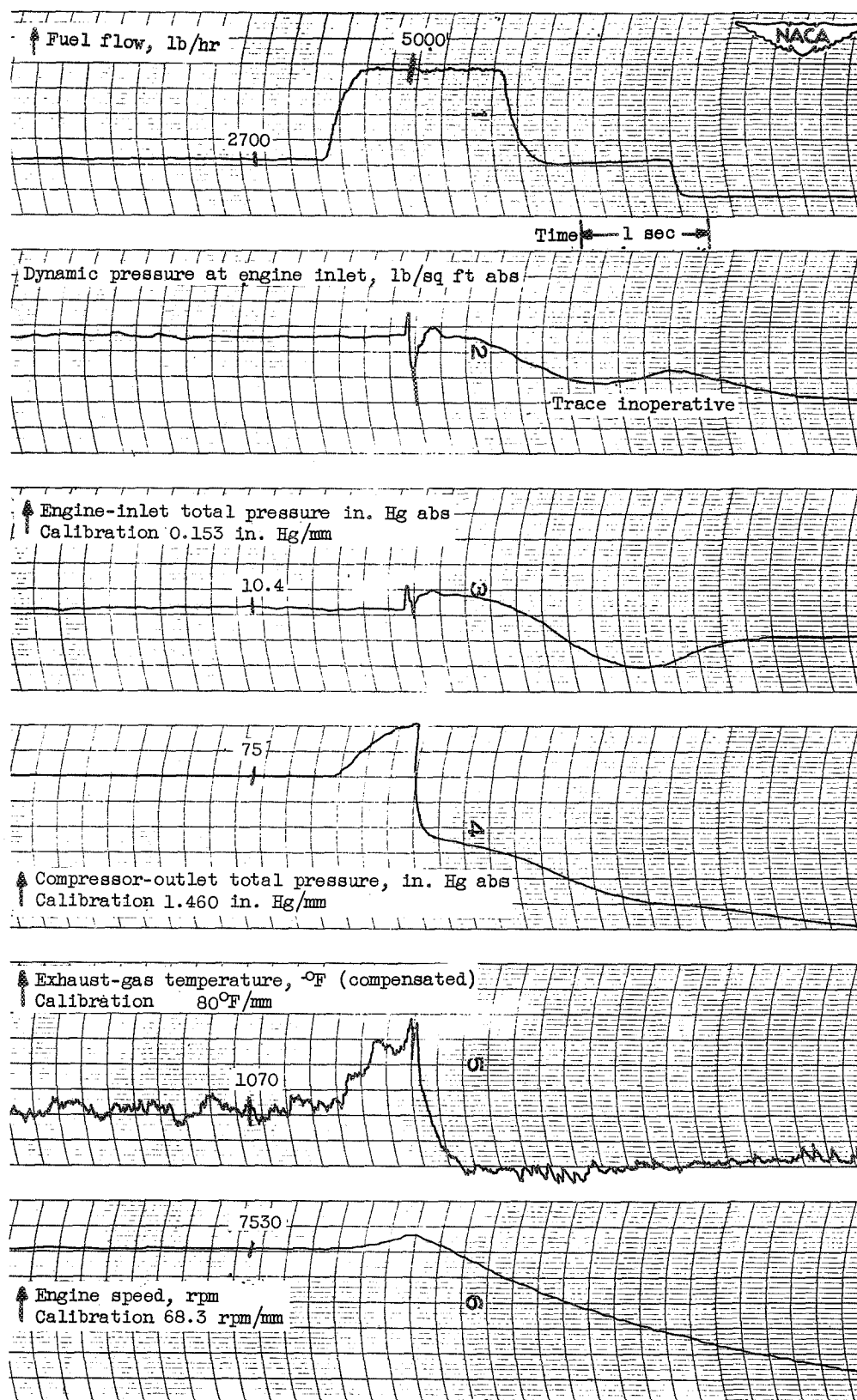


Figure 58

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -10° F; inlet guide vanes position, open.

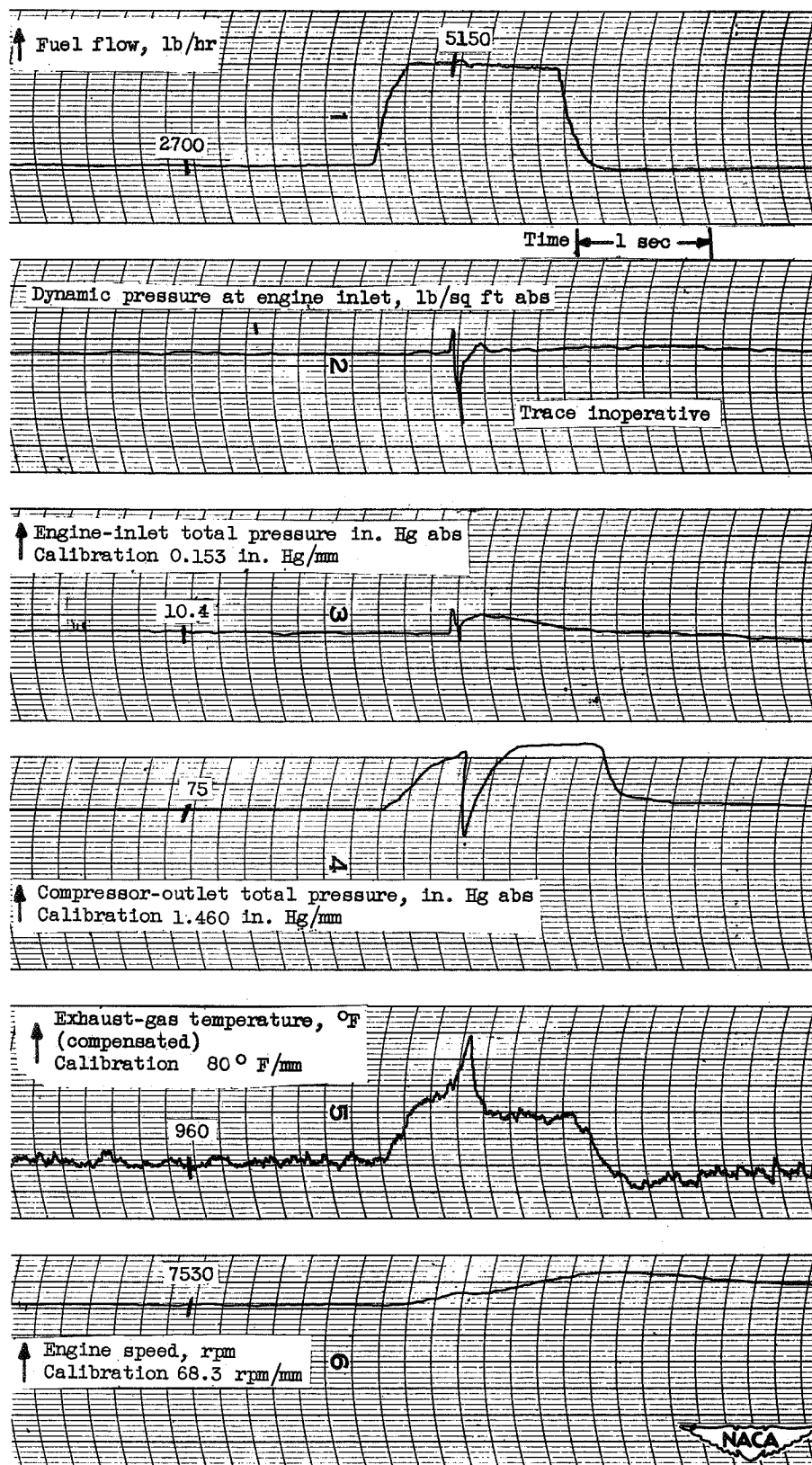


Figure 59

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -10°F ; inlet guide vanes position, open.

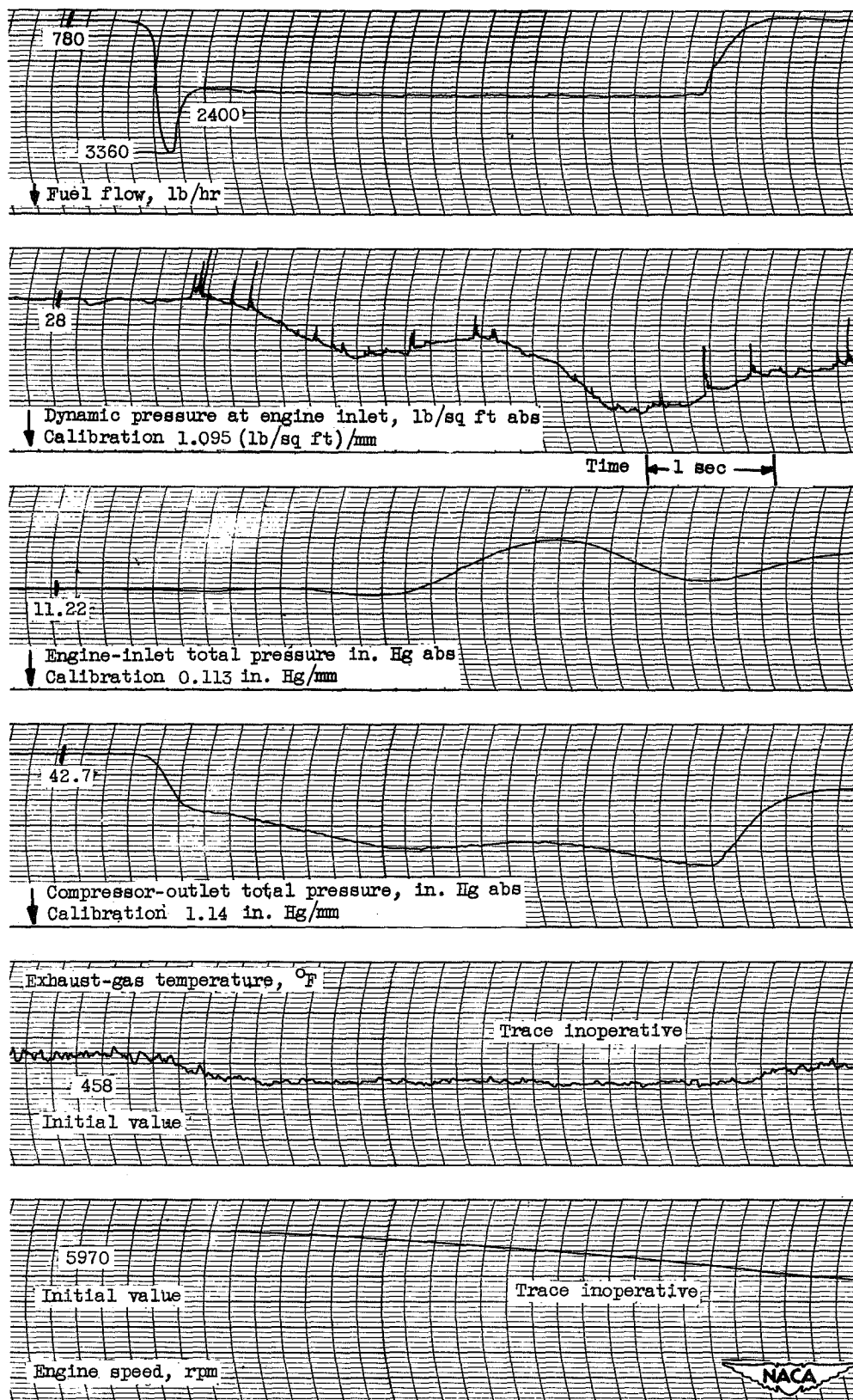


Figure 60

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 30° F; inlet guide vanes position, open.

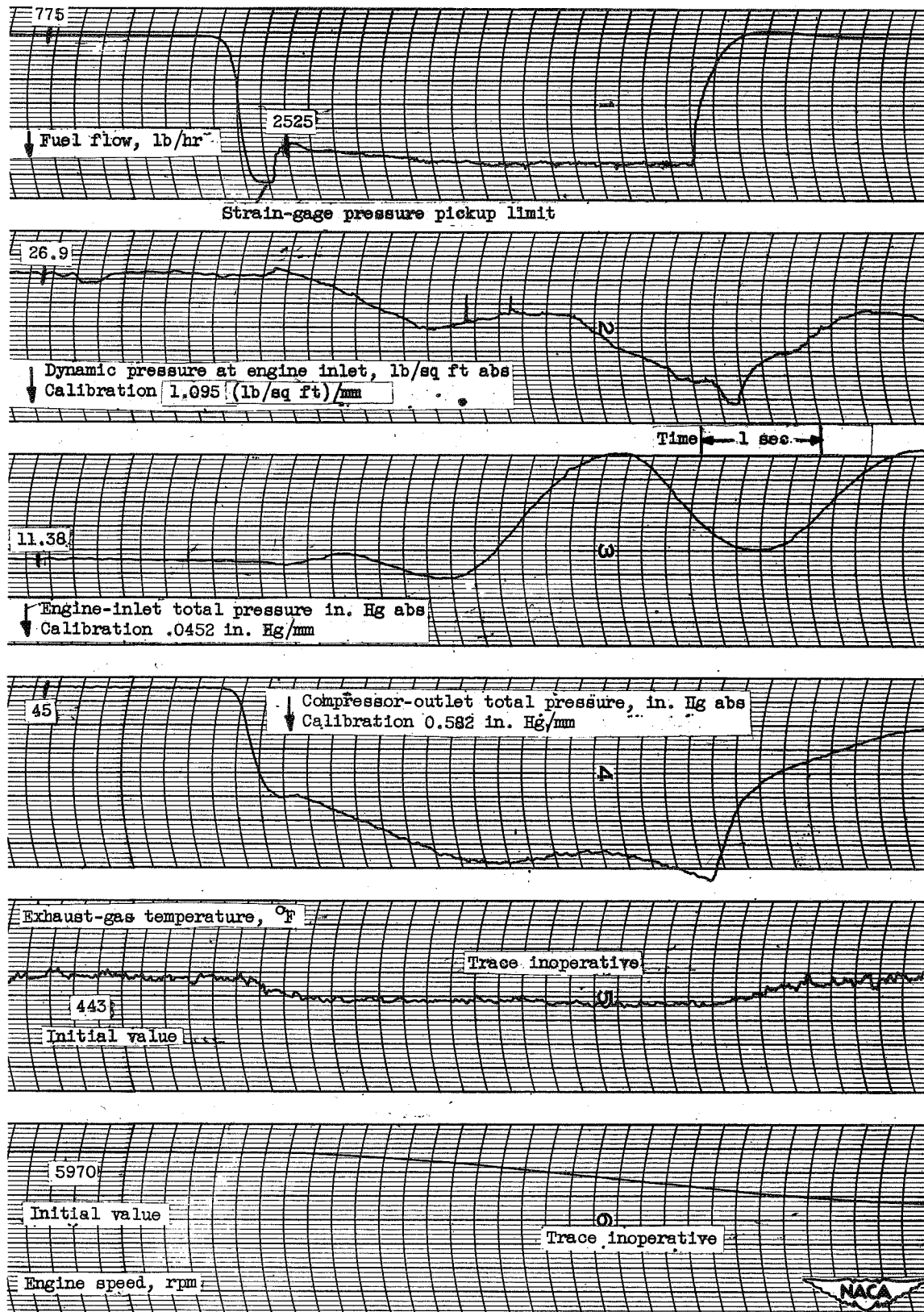


Figure 61

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 28° F; inlet guide vanes position, open.

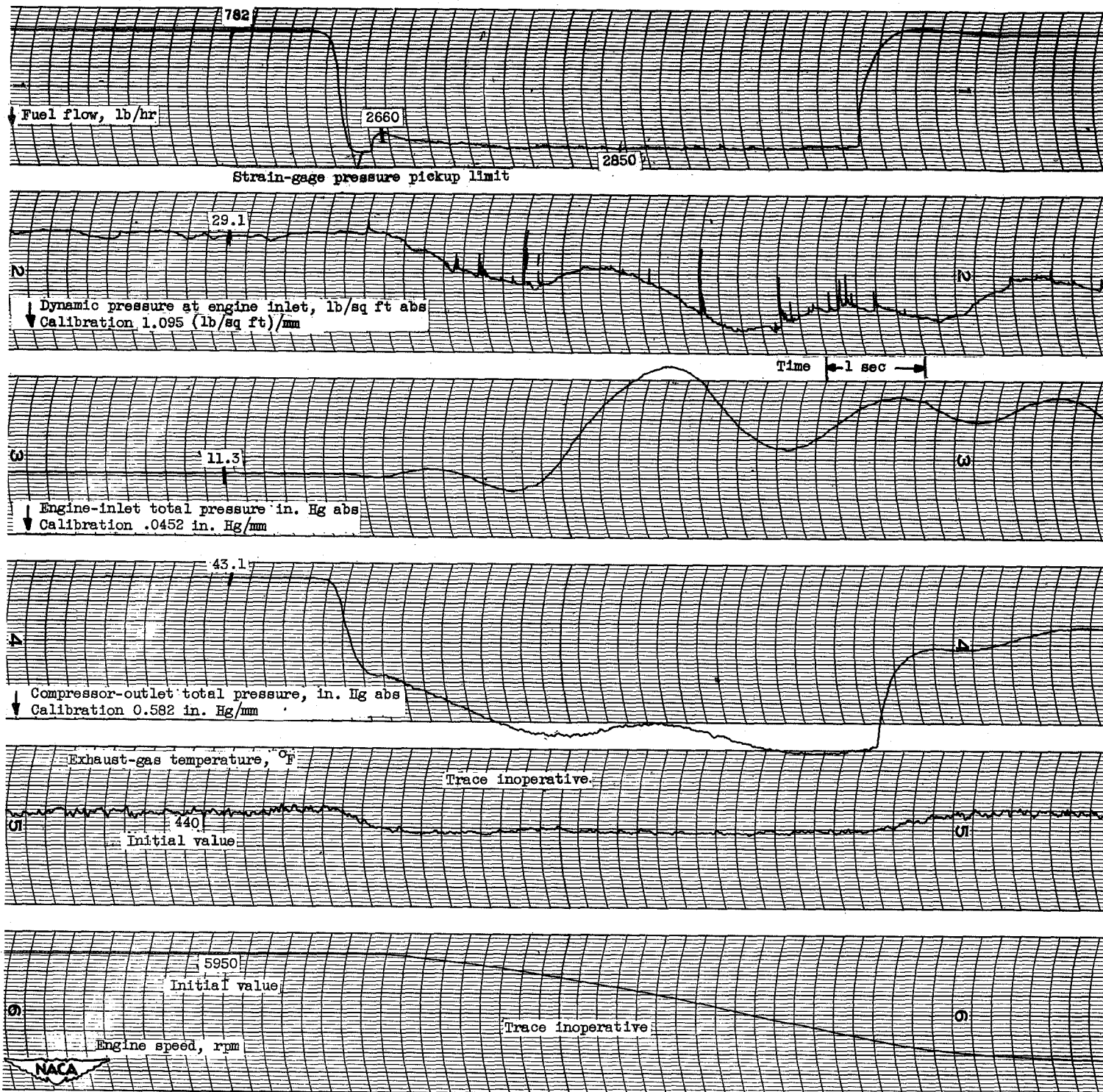


Figure 62

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 28 ° F; inlet guide vanes position, open.

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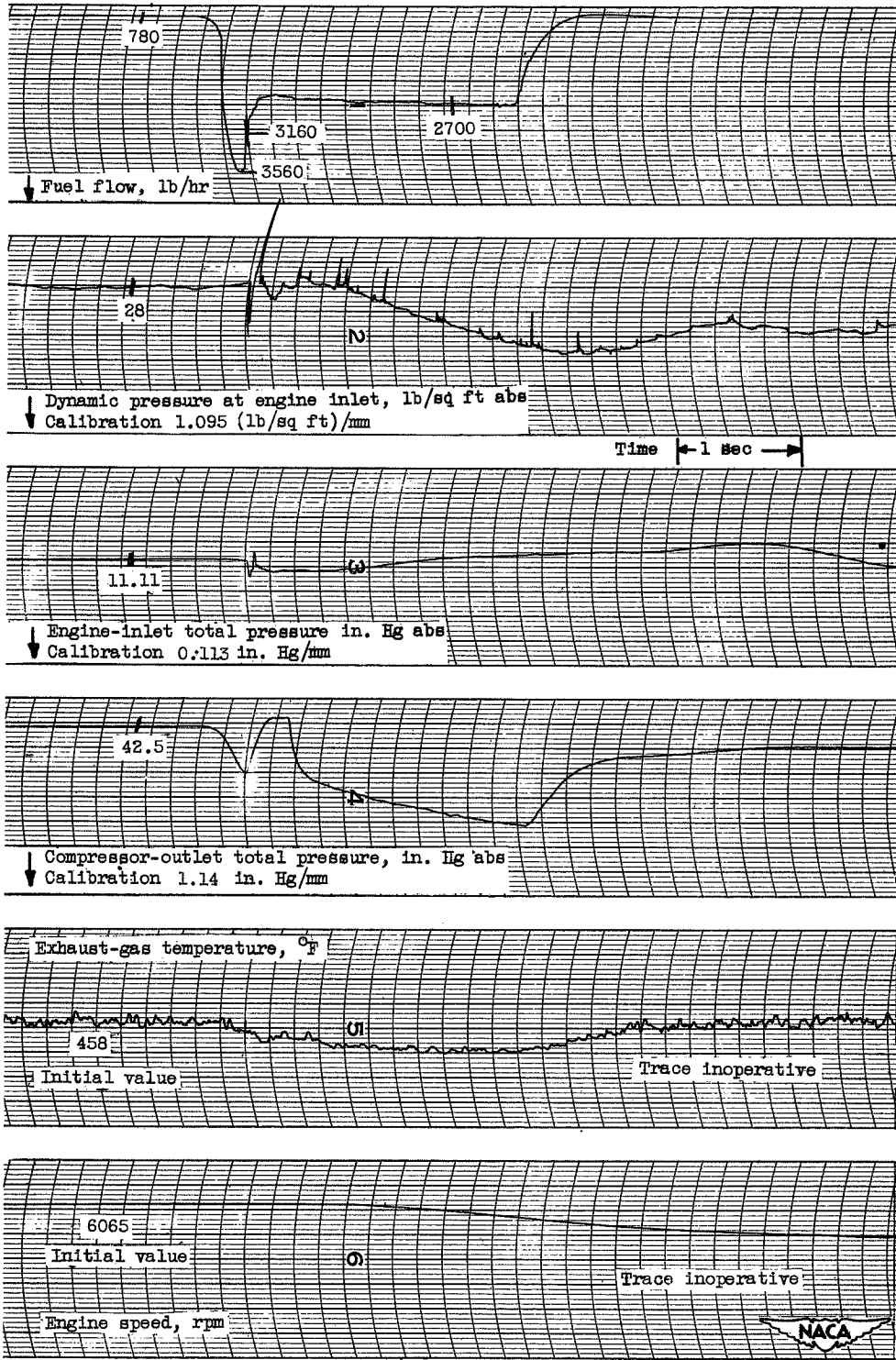


Figure 63

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 30° F; inlet guide vanes position, open.

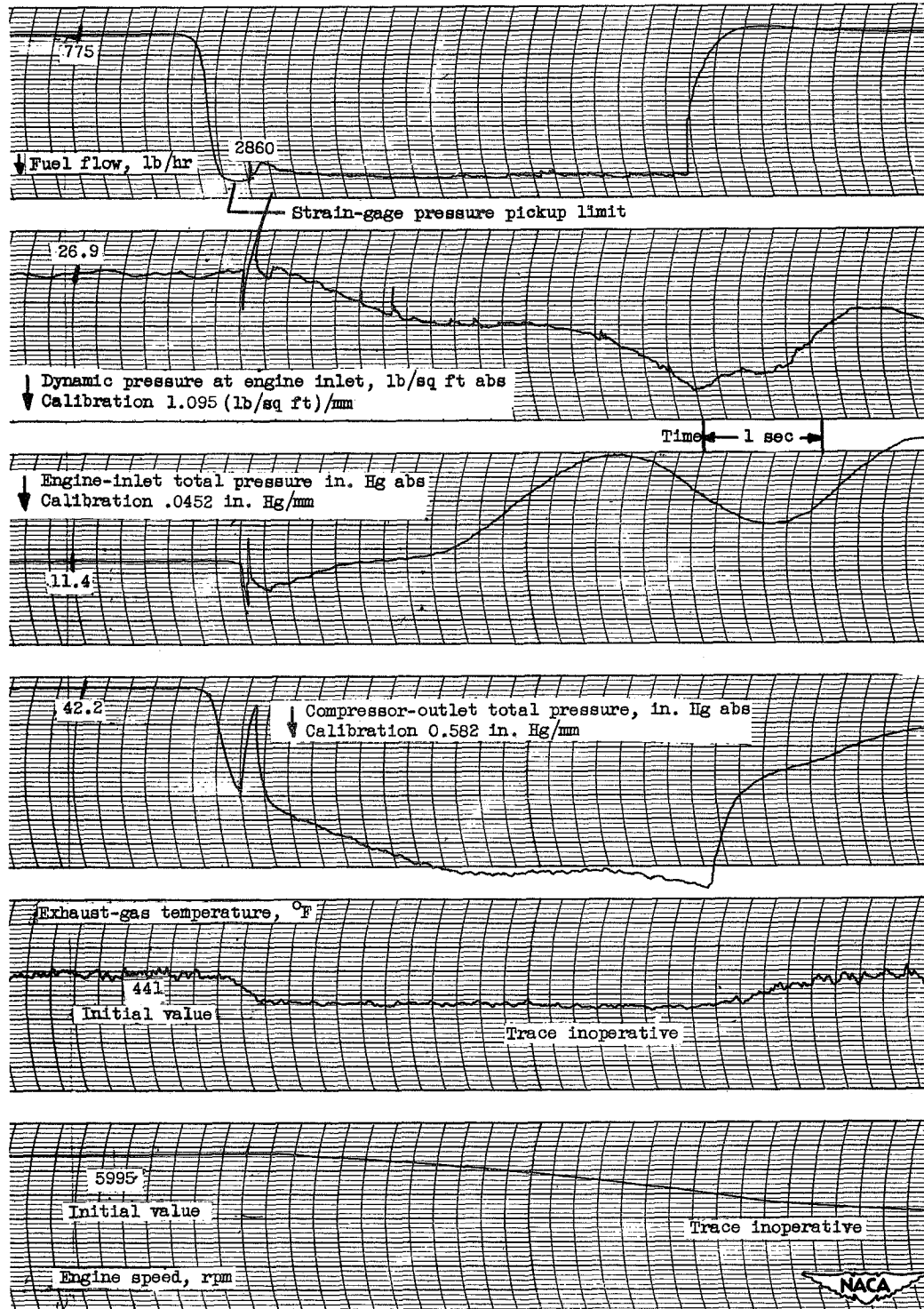


Figure 64

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 28 ° F; inlet guide vanes position, open.

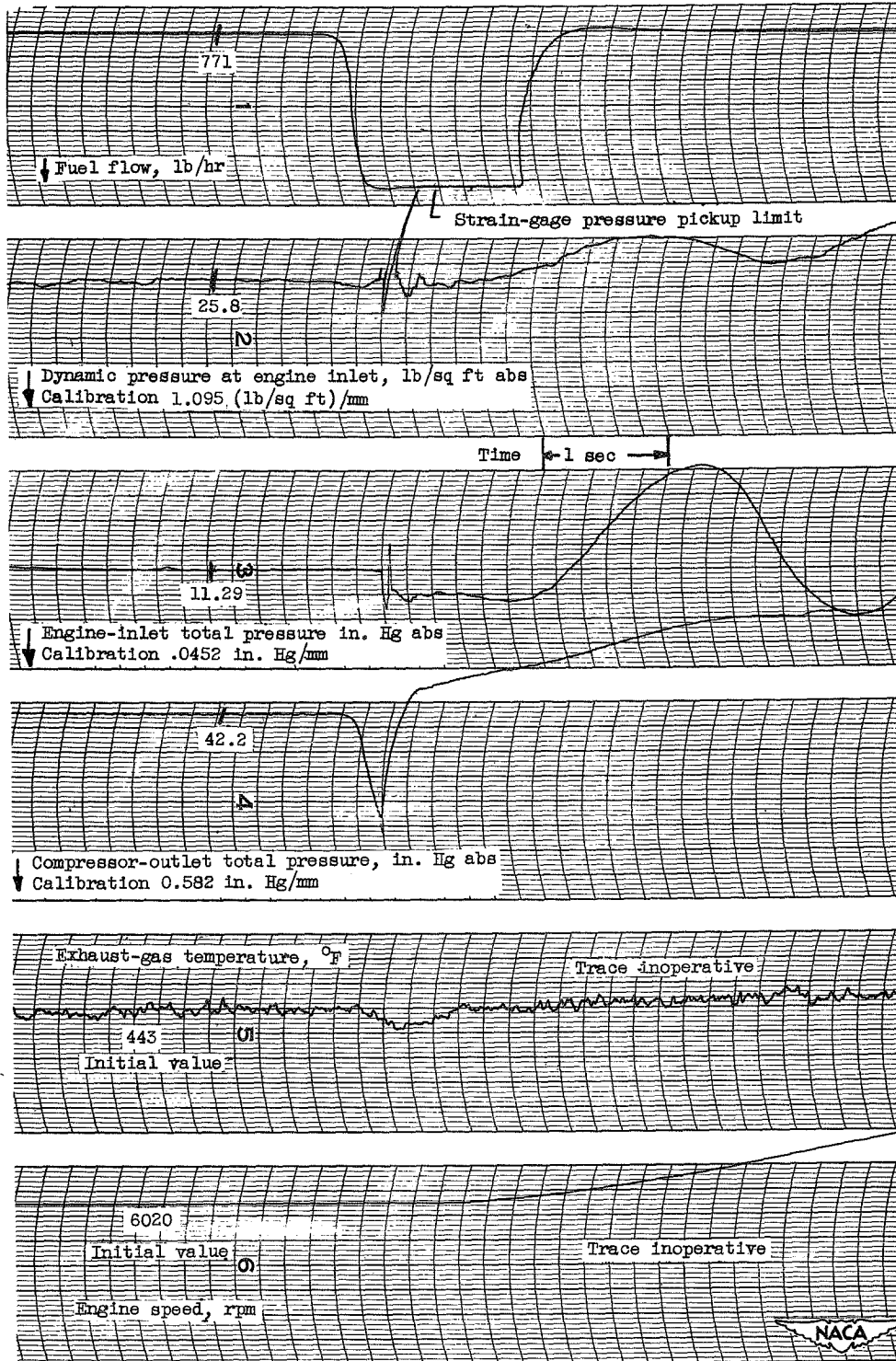


Figure 65
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 28° F; inlet guide vanes position, open.

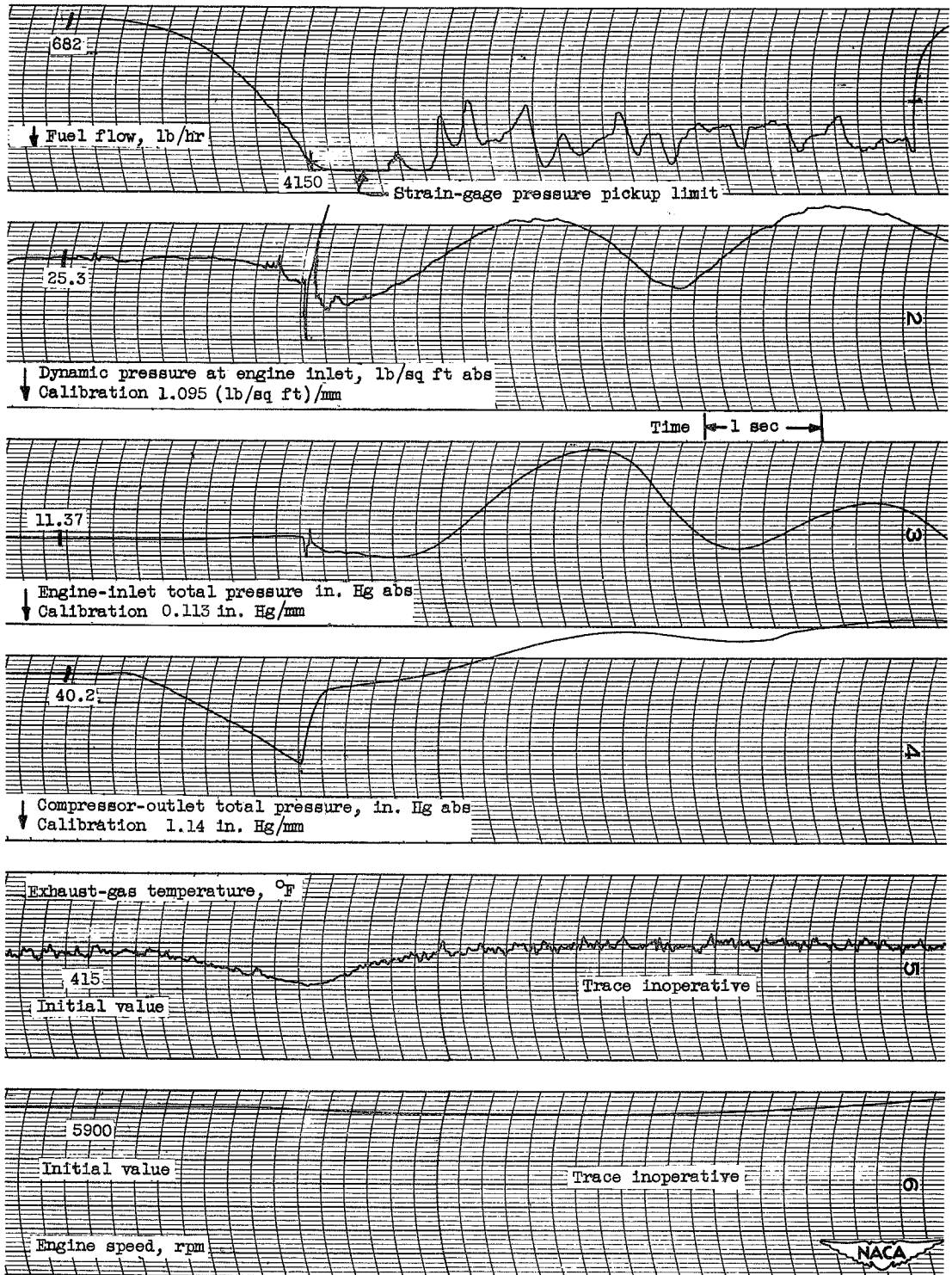


Figure 66
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 30° F; inlet guide vanes position, open.

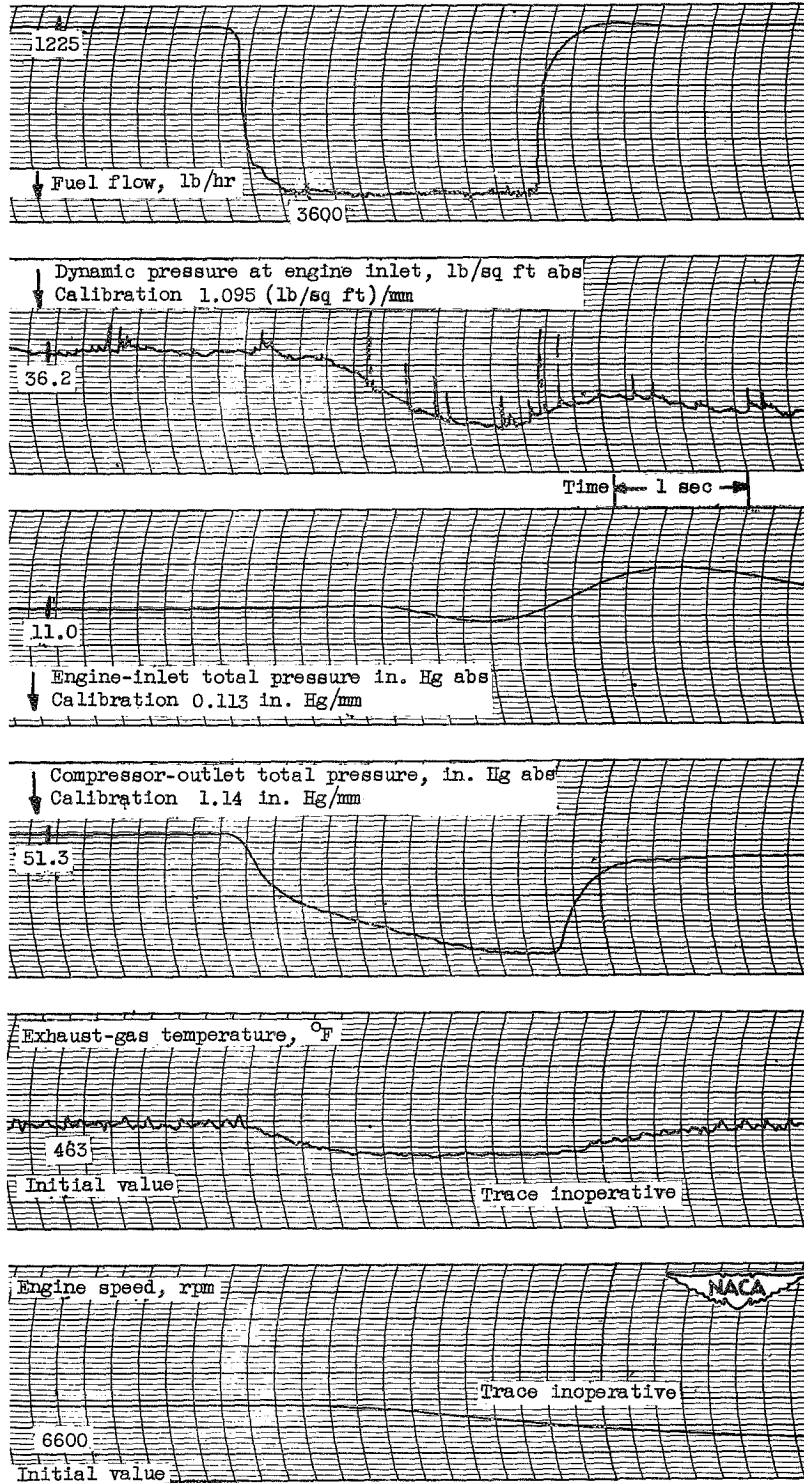


Figure 67

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 30° F; inlet guide vanes position, open.

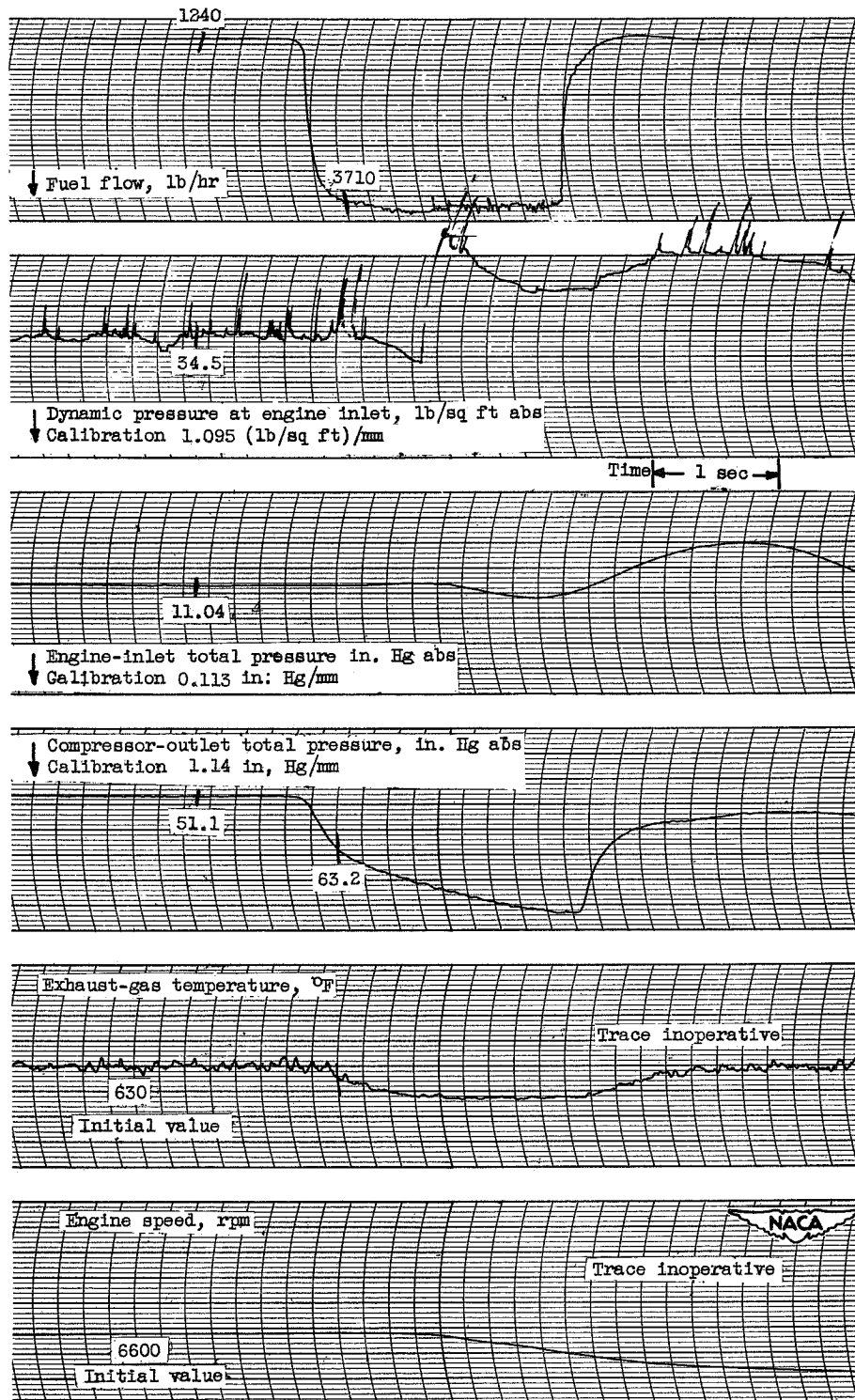


Figure 68

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 30° F; inlet guide vanes position, open.

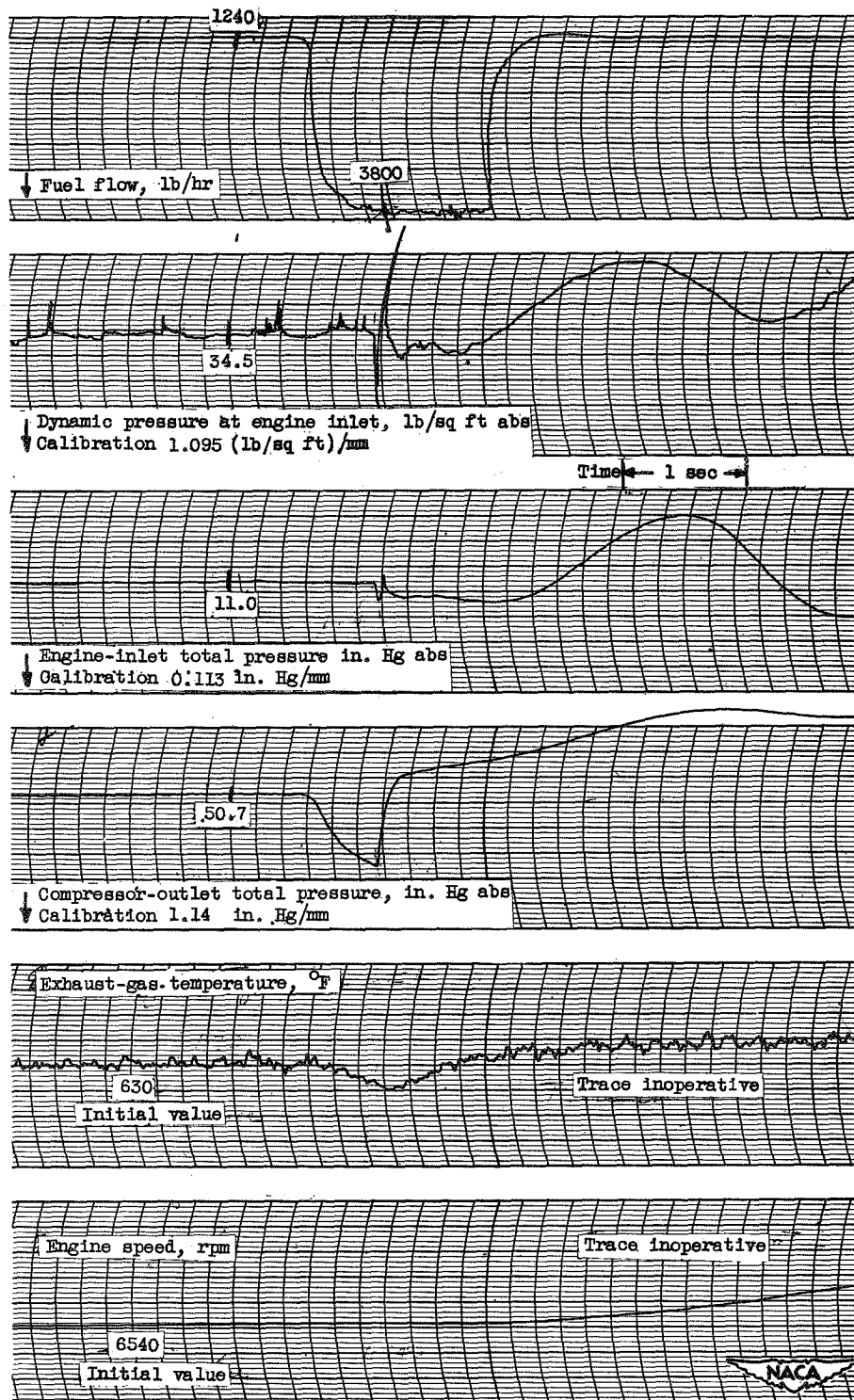


Figure 69

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 30 ° F; inlet guide vanes position, open.

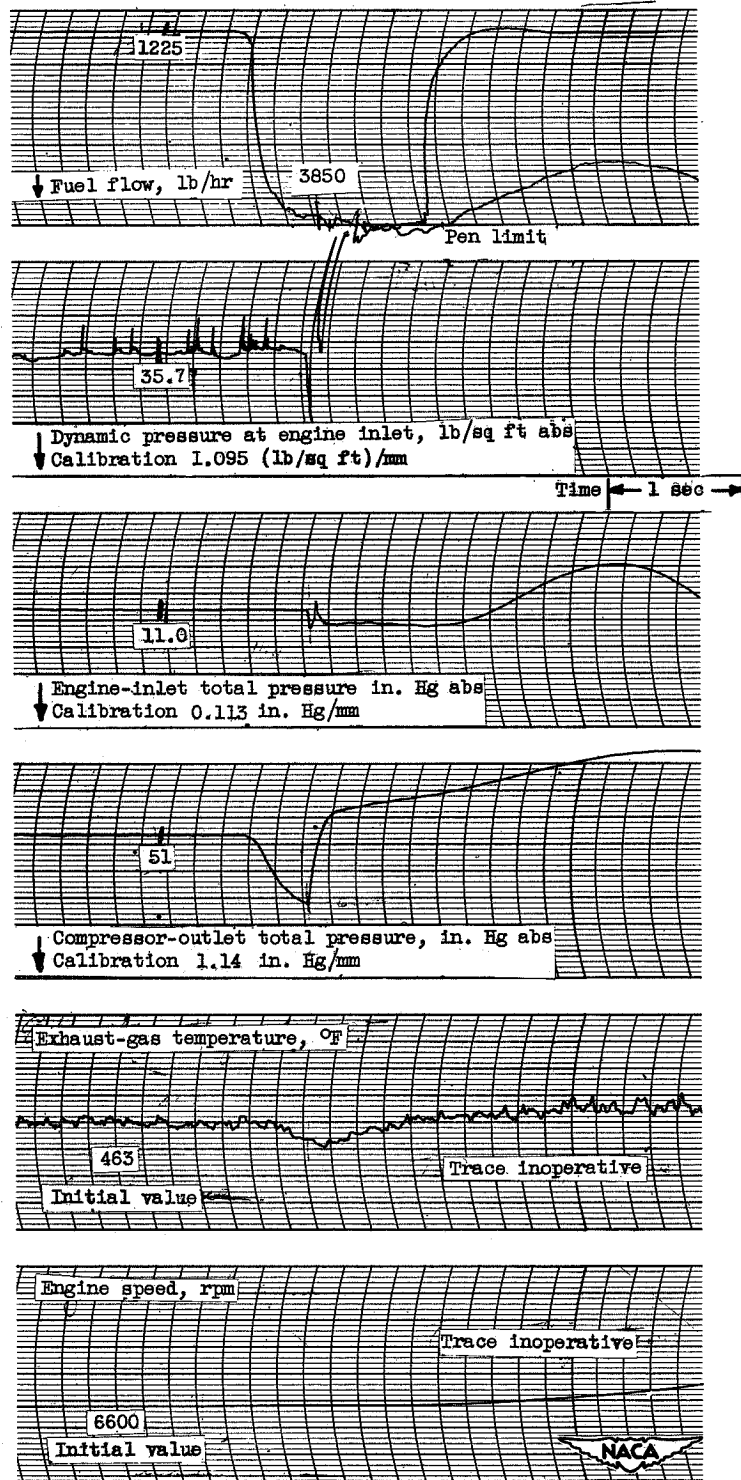


Figure 70

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 30° F; inlet guide vanes position, open.

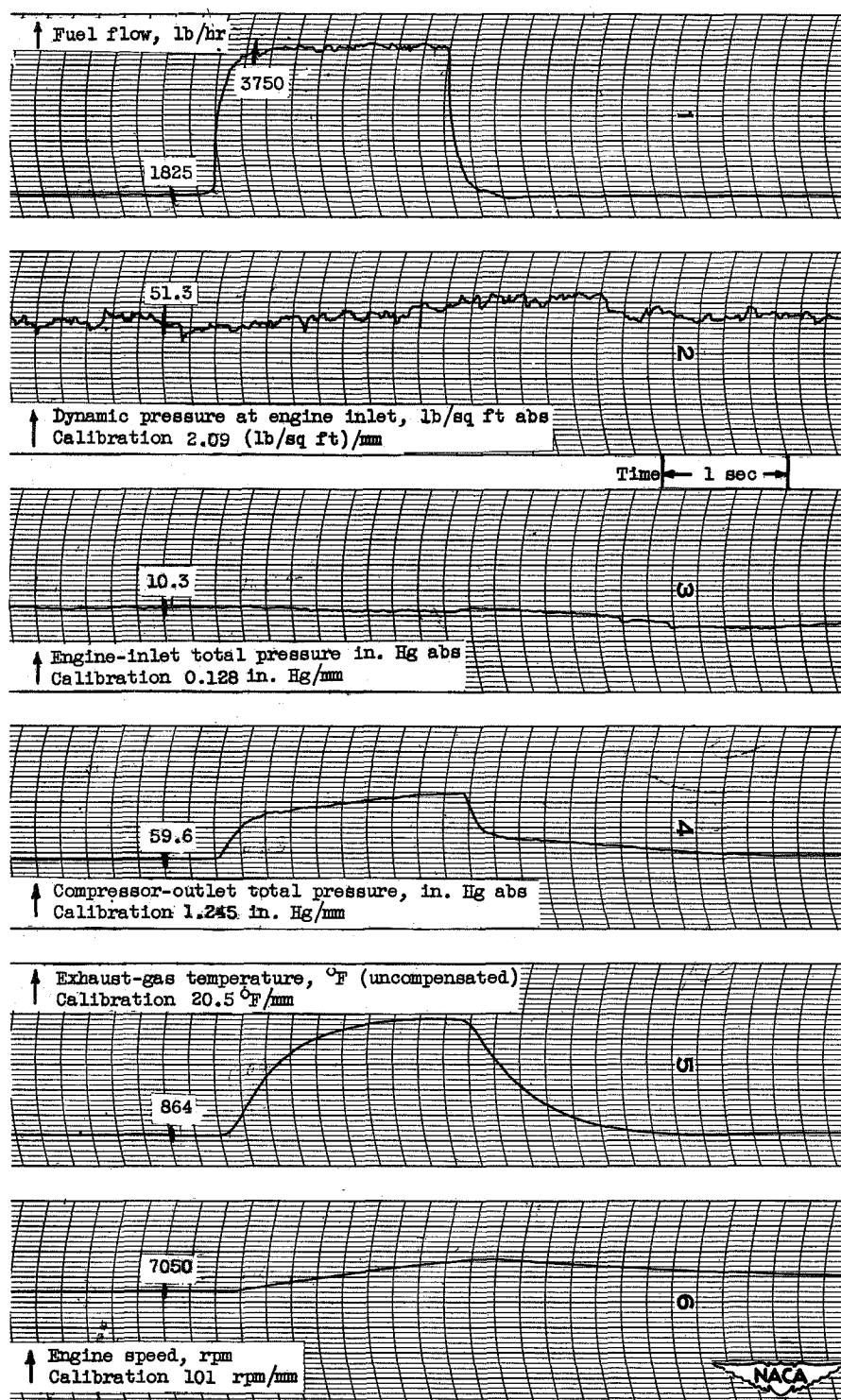


Figure 71

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 38° F; inlet guide vanes position, open.

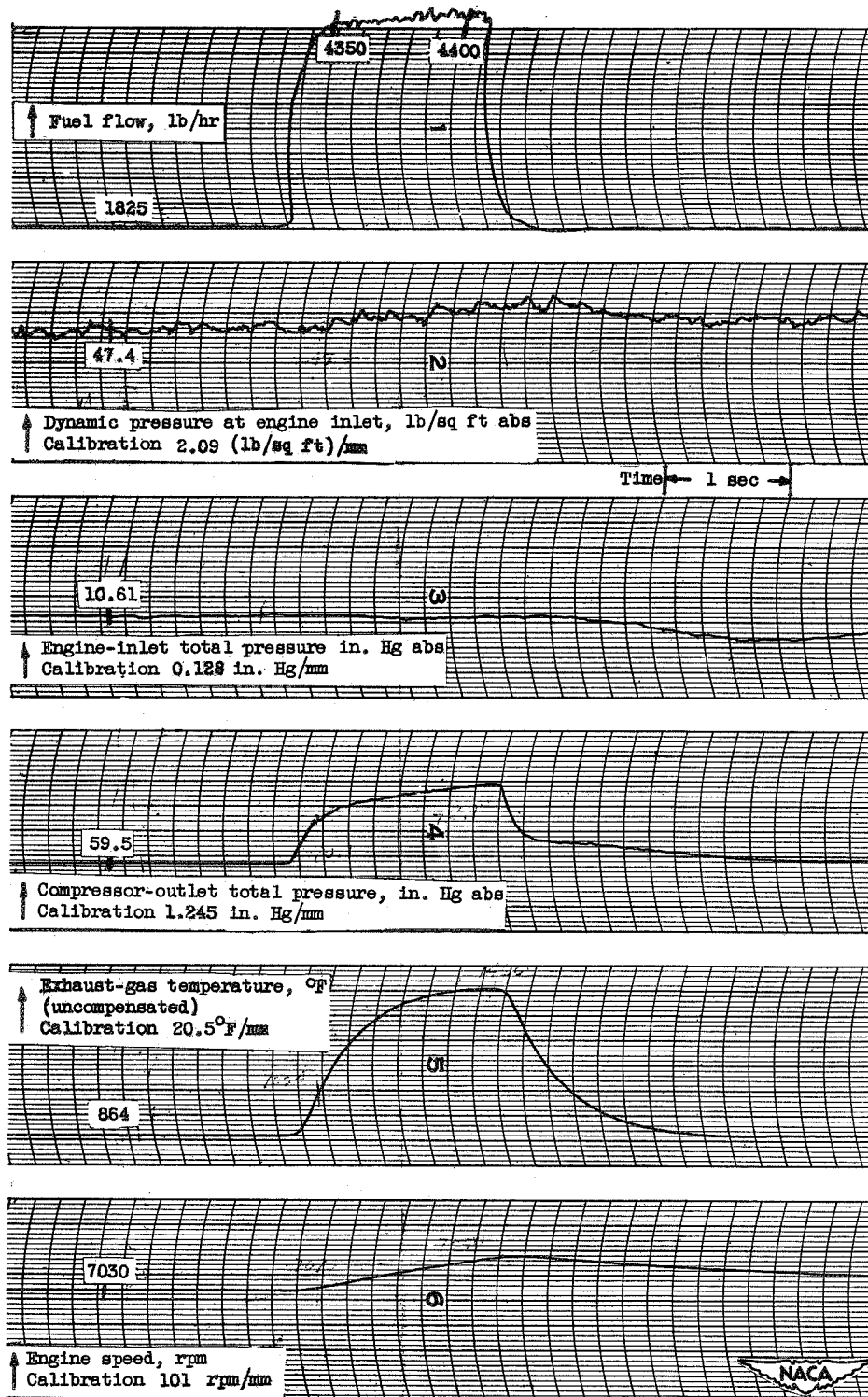


Figure 72

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 38° F; inlet guide vanes position, open.

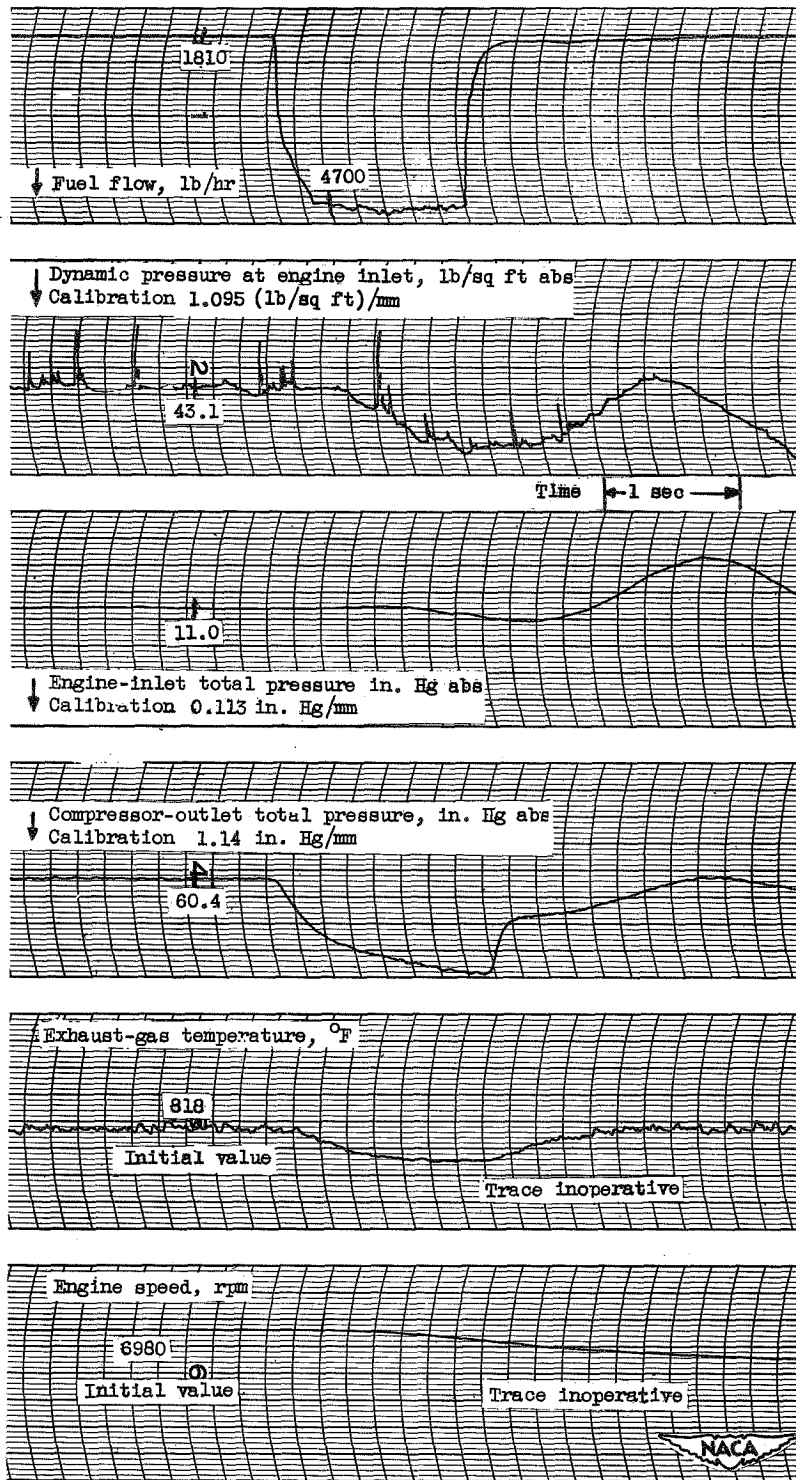


Figure 73

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 30° F; inlet guide vanes position, open.

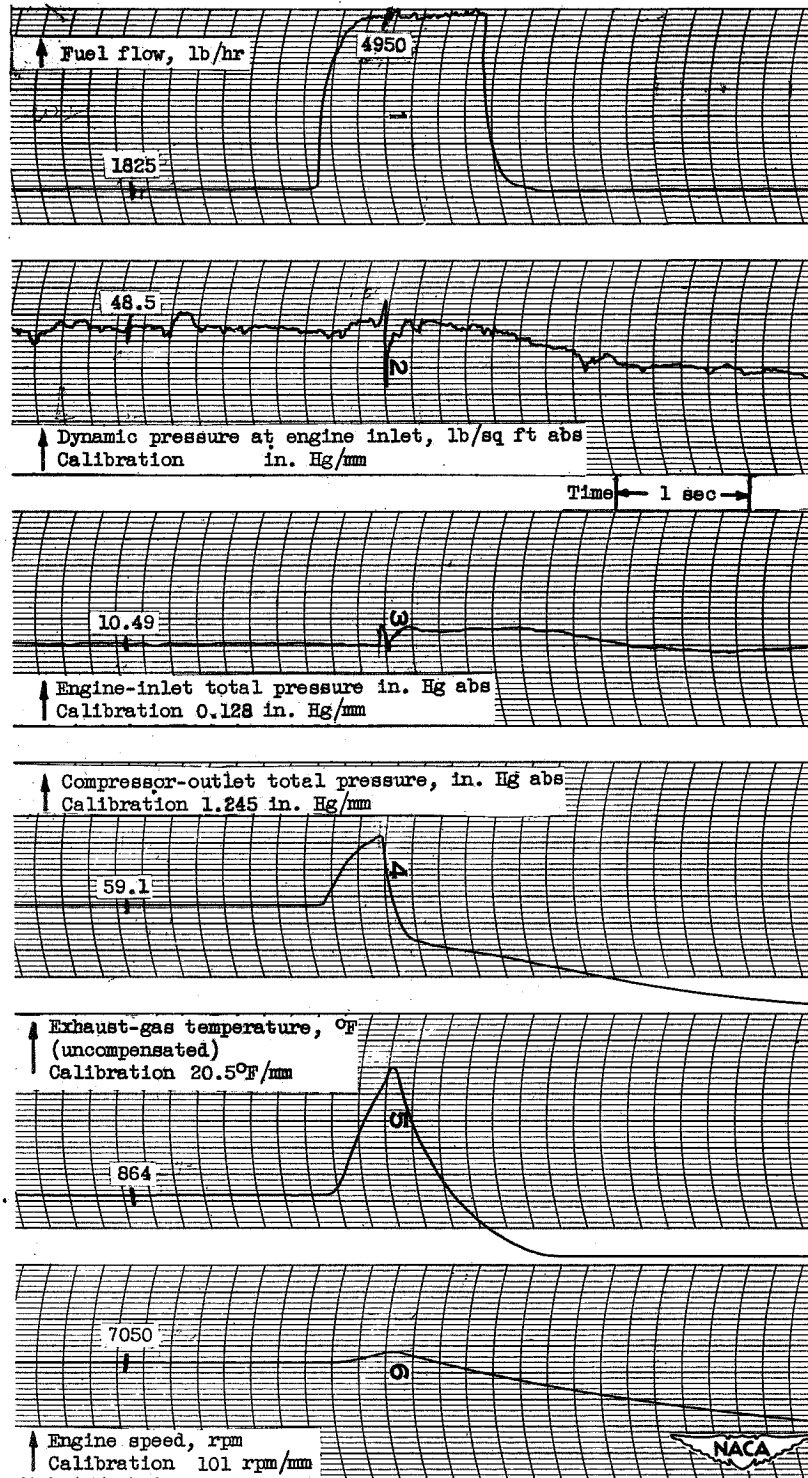


Figure 74

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 39° F; inlet guide vanes position, open.

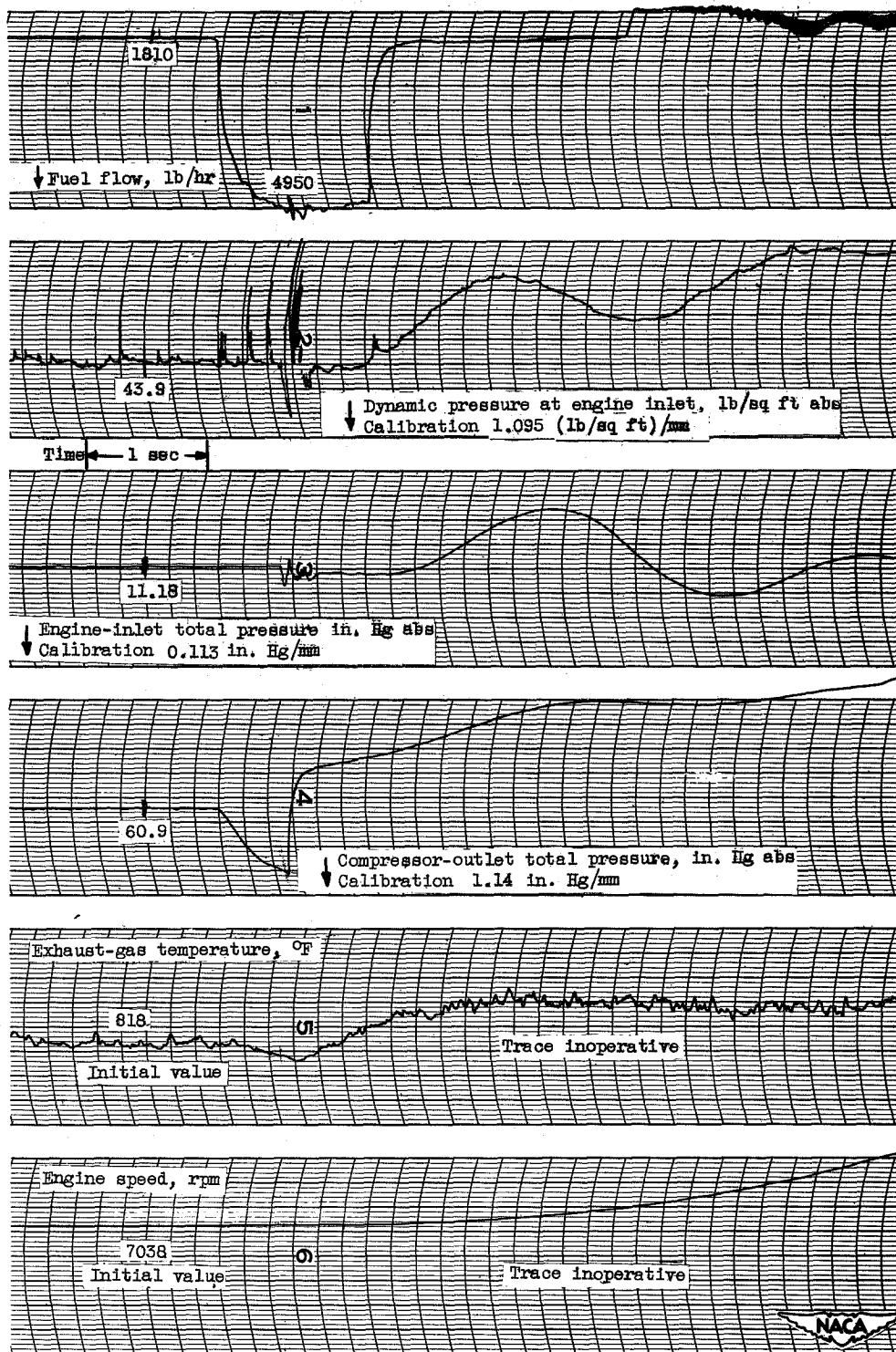


Figure 75
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 30° F; inlet guide vanes position, open.

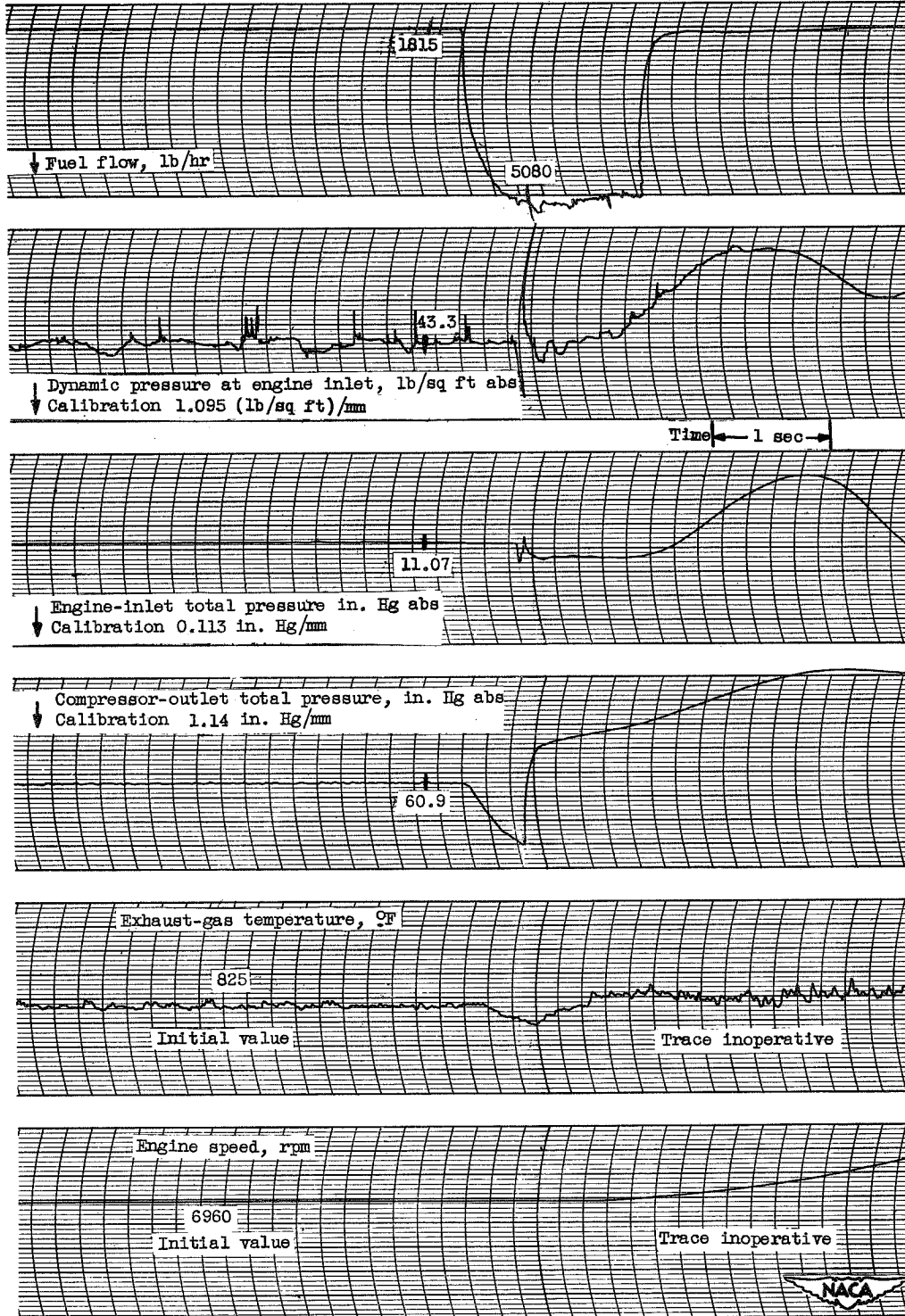


Figure 76

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 30° F; inlet guide vanes position, open.

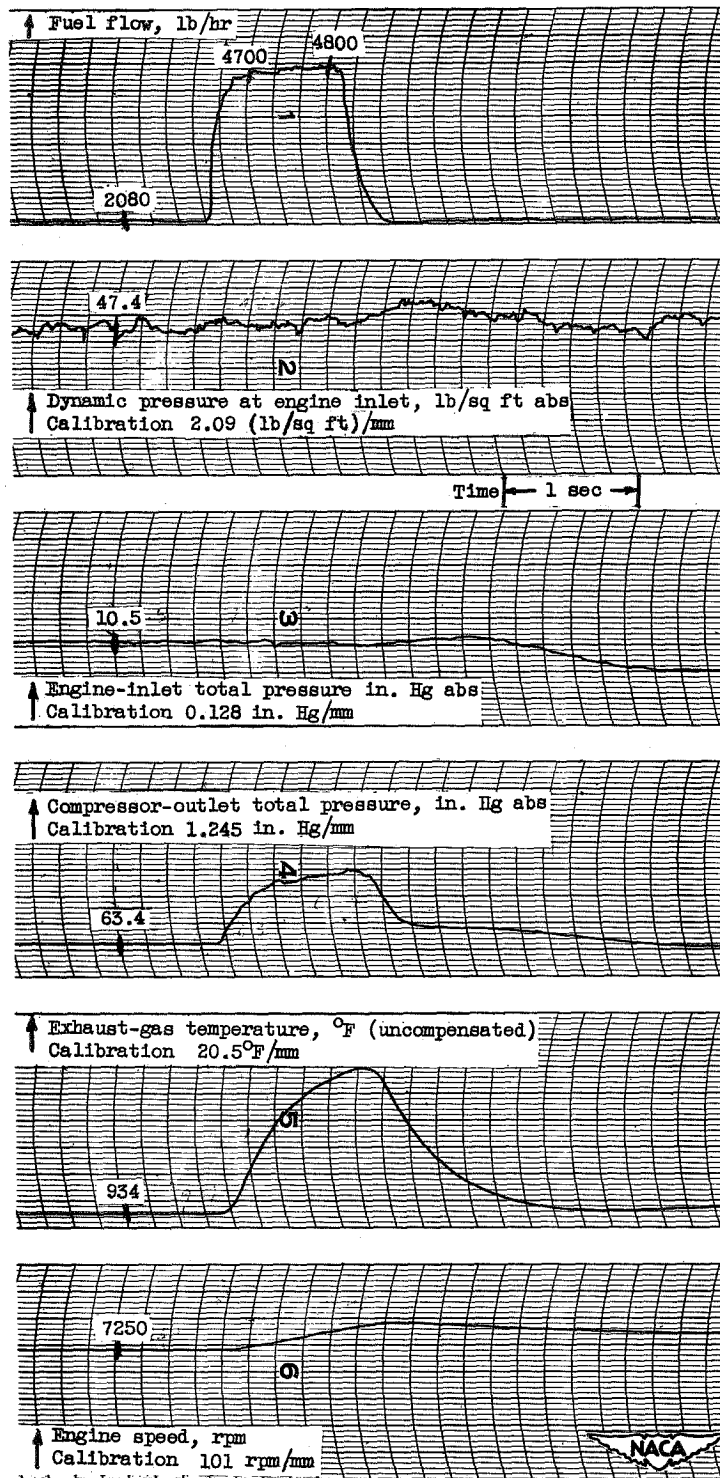


Figure 77

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 39 ° F; inlet guide vanes position, open.

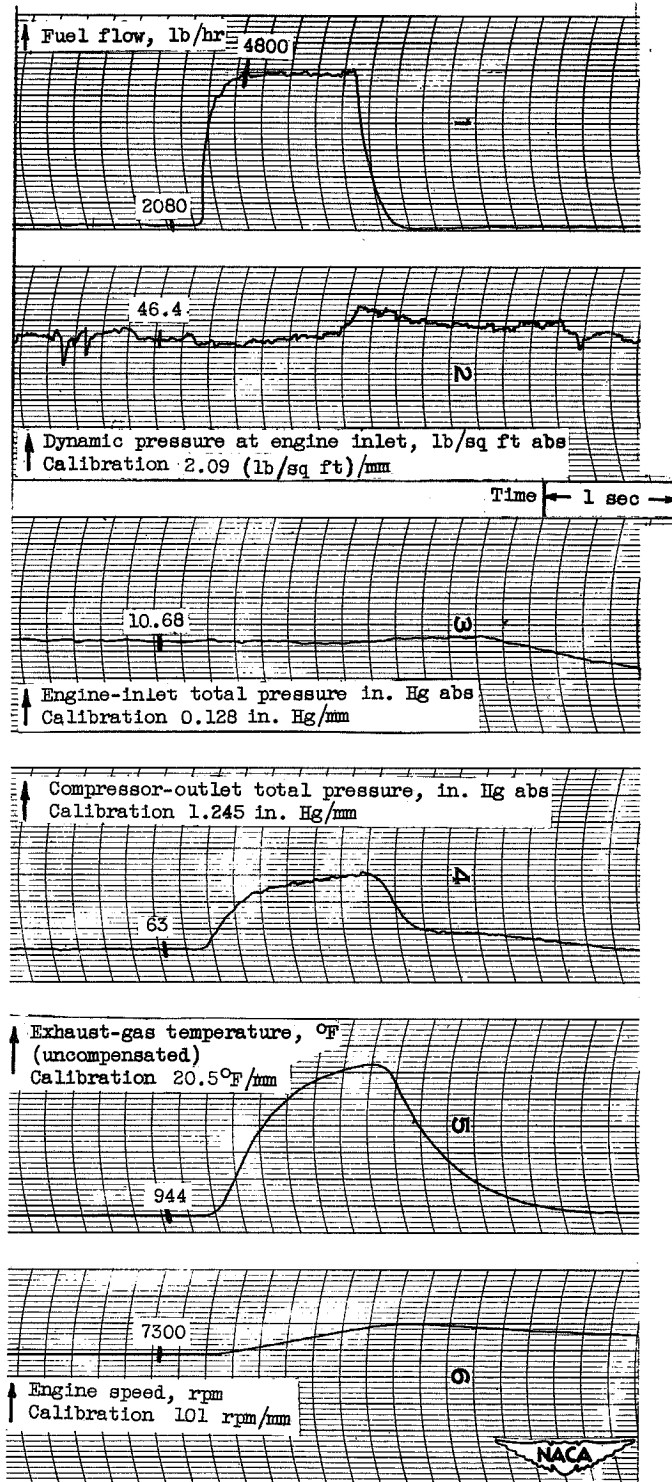


Figure 78

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 39° F; inlet guide vanes position, open.

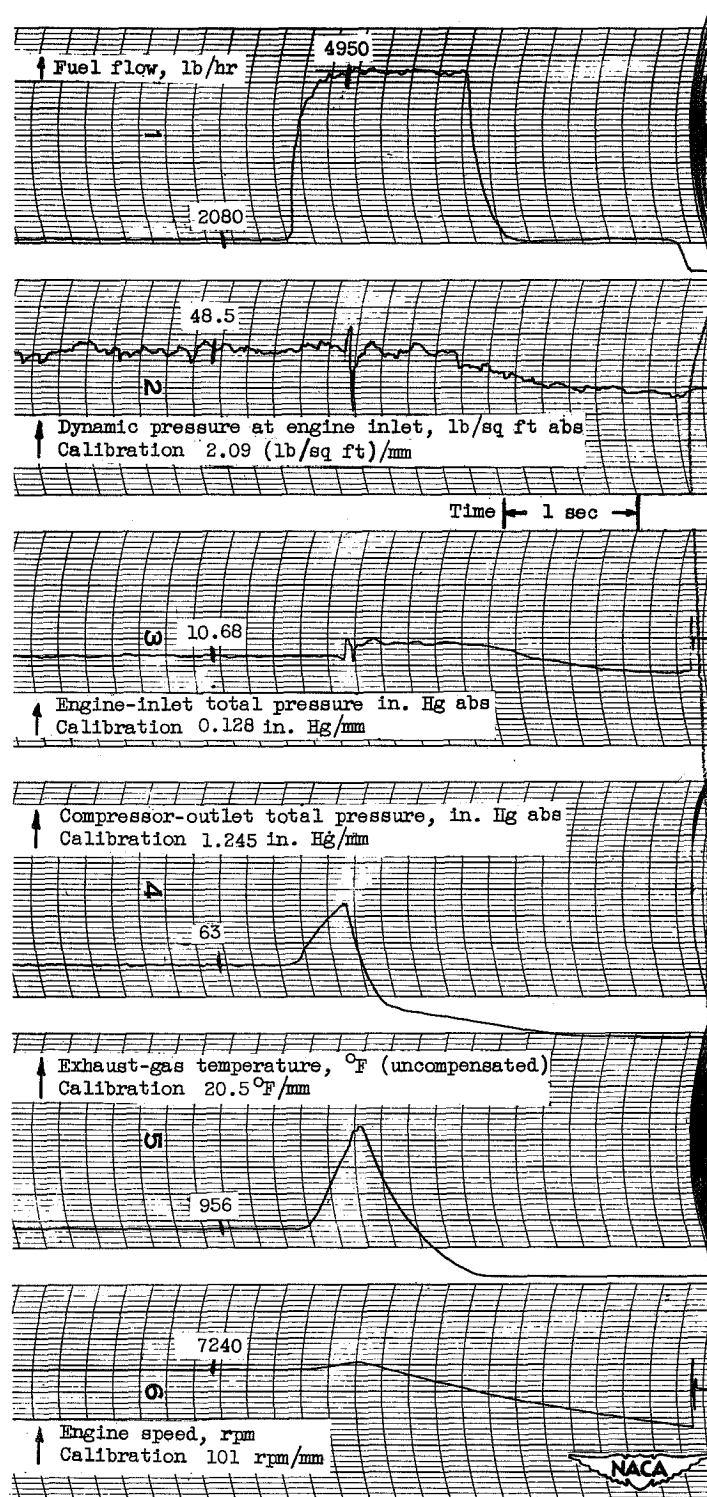


Figure 79
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 38° F; inlet guide vanes position, open.

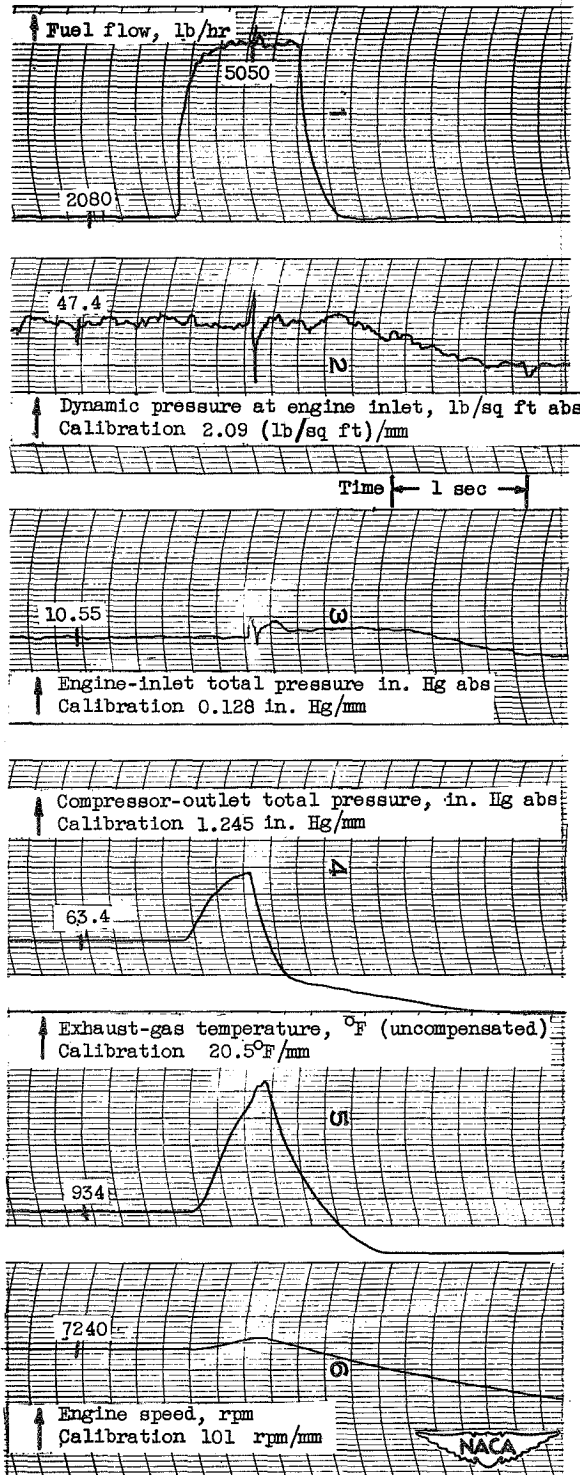


Figure 80

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 39° F; inlet guide vanes position, open.

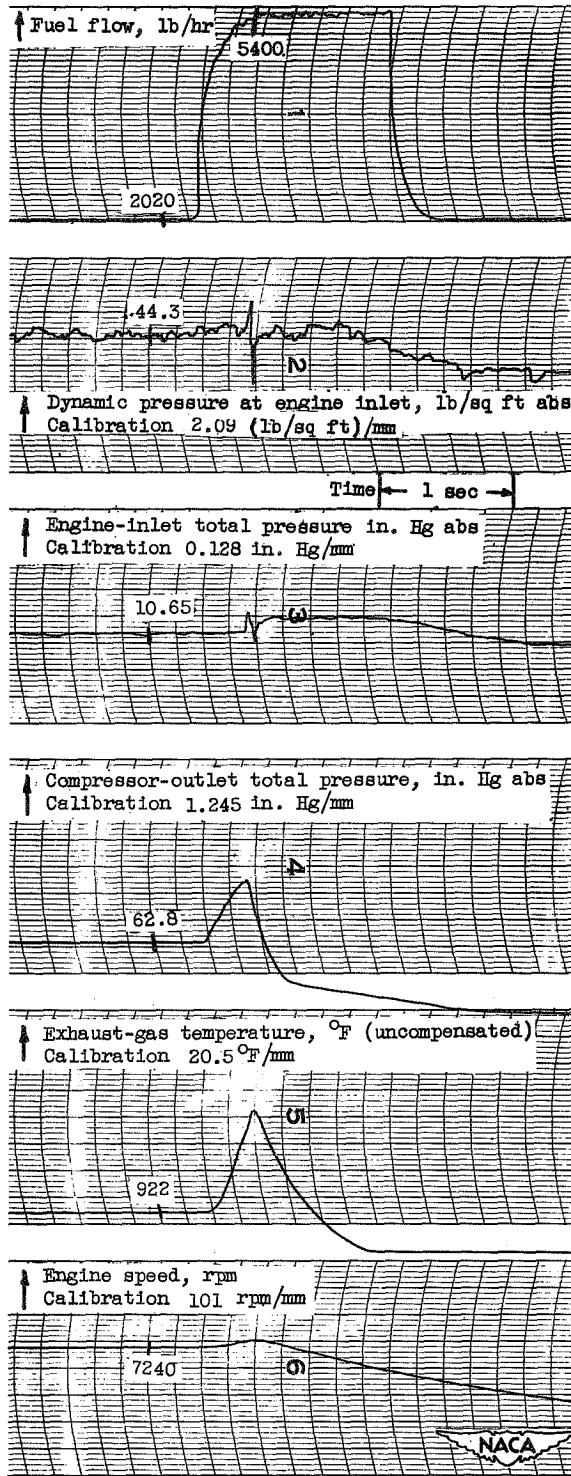


Figure 81

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 39° F; inlet guide vanes position, open.

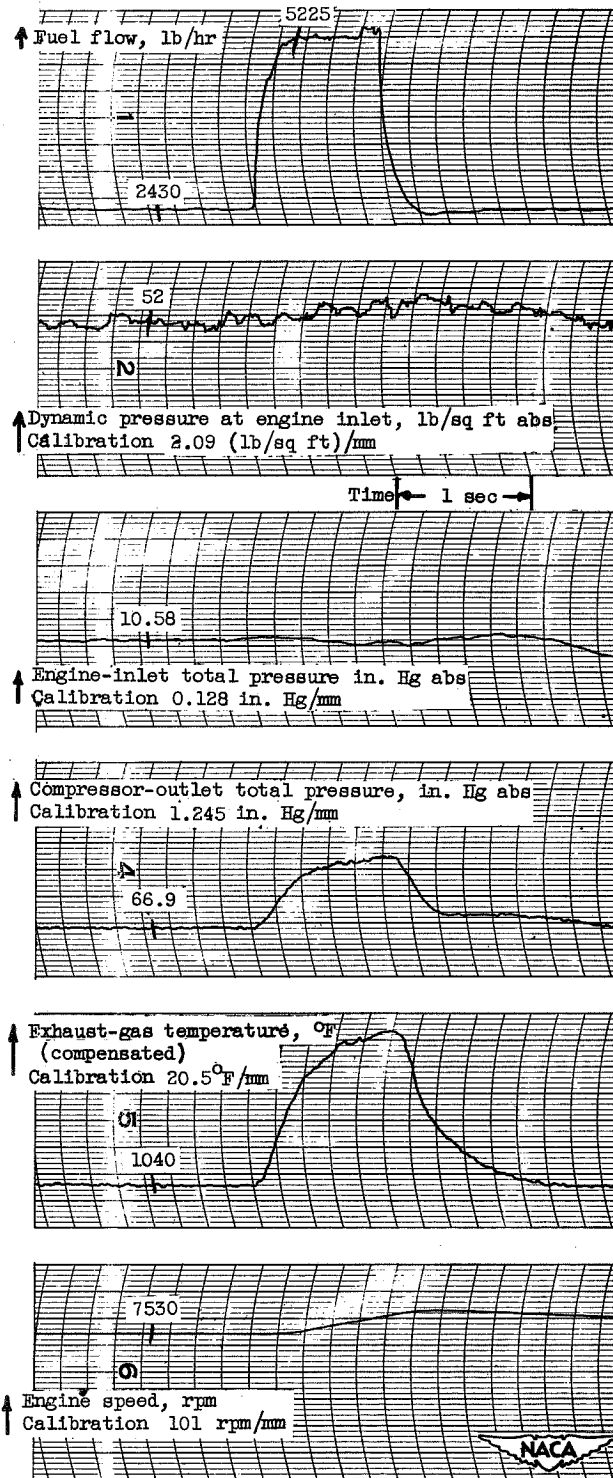


Figure 82

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 39° F; inlet guide vanes position, open.

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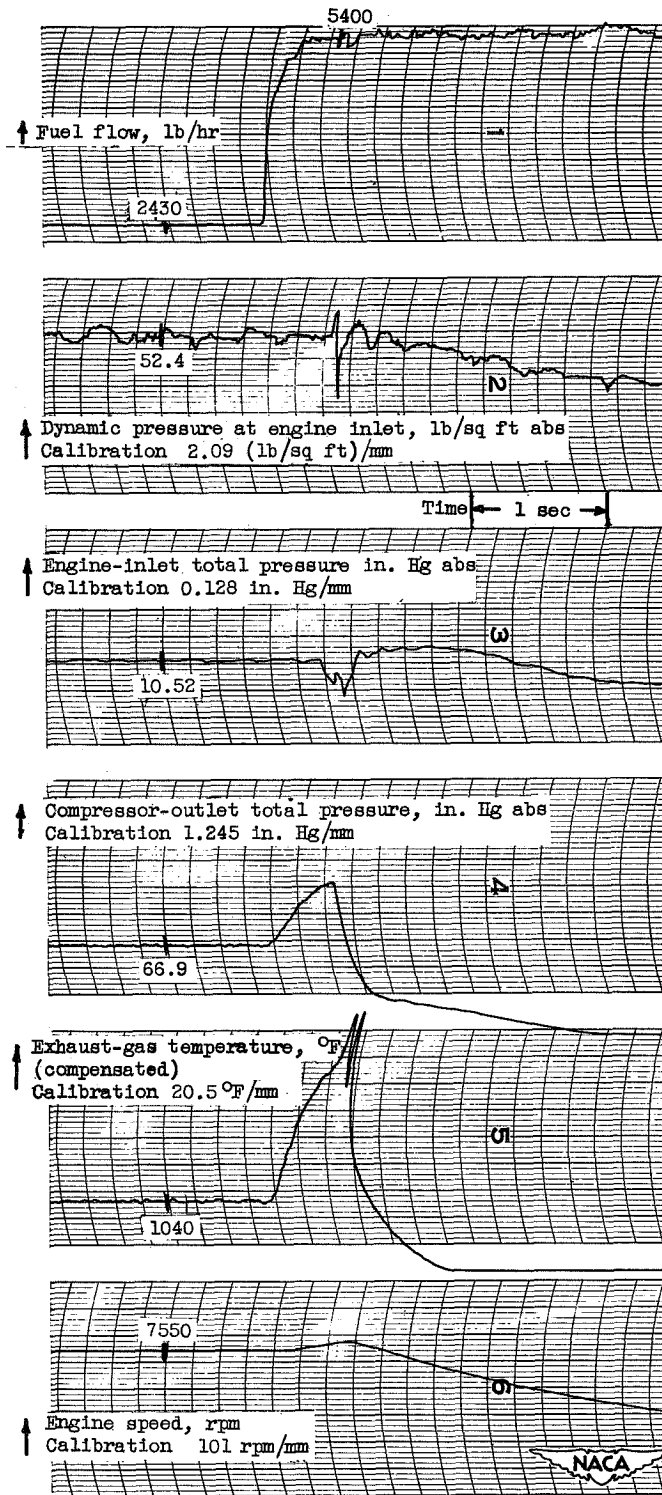


Figure 83

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow; Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 39° F; inlet guide vanes position, open.

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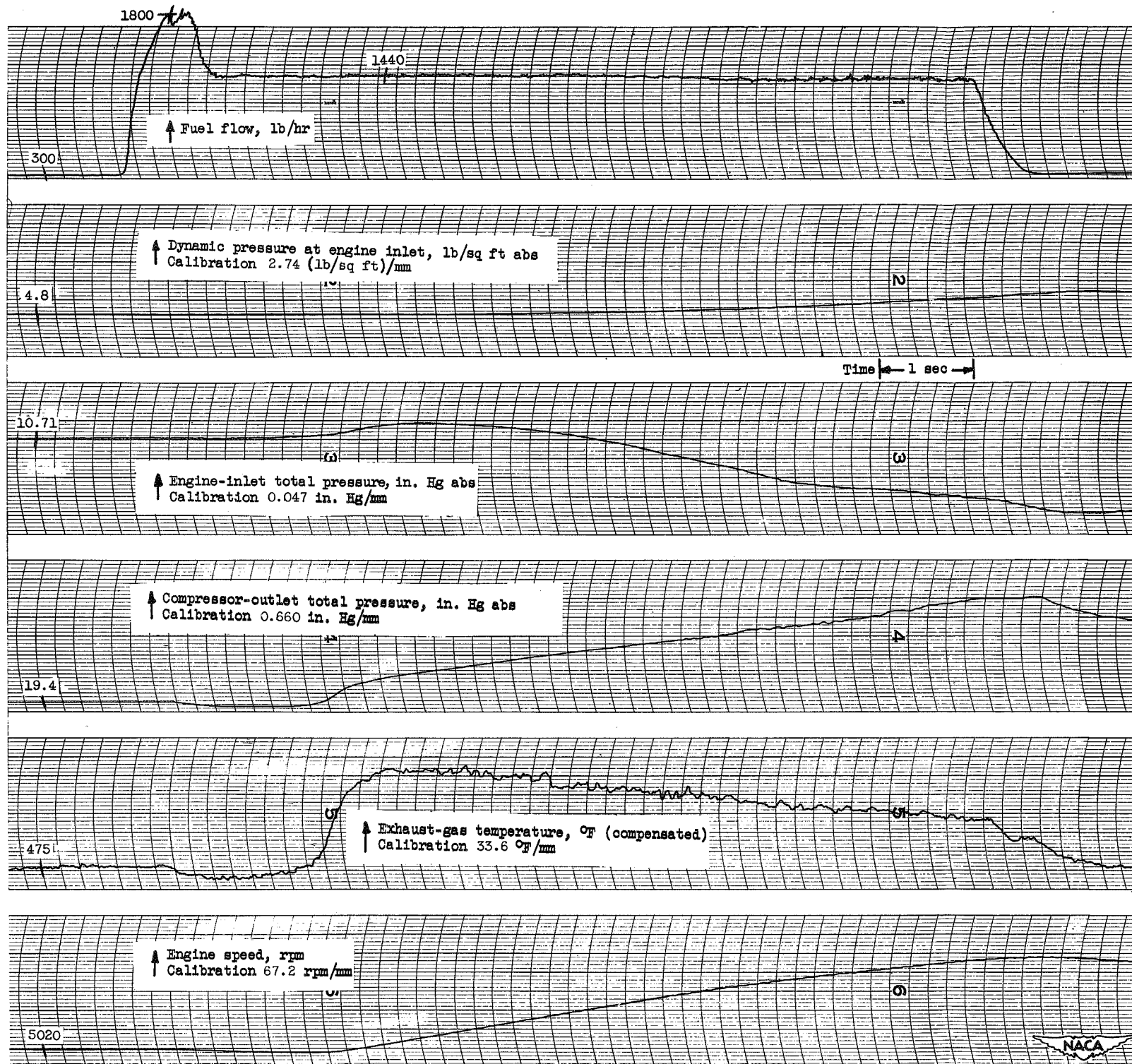


Figure 84

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 150° F; inlet guide vanes position, open.

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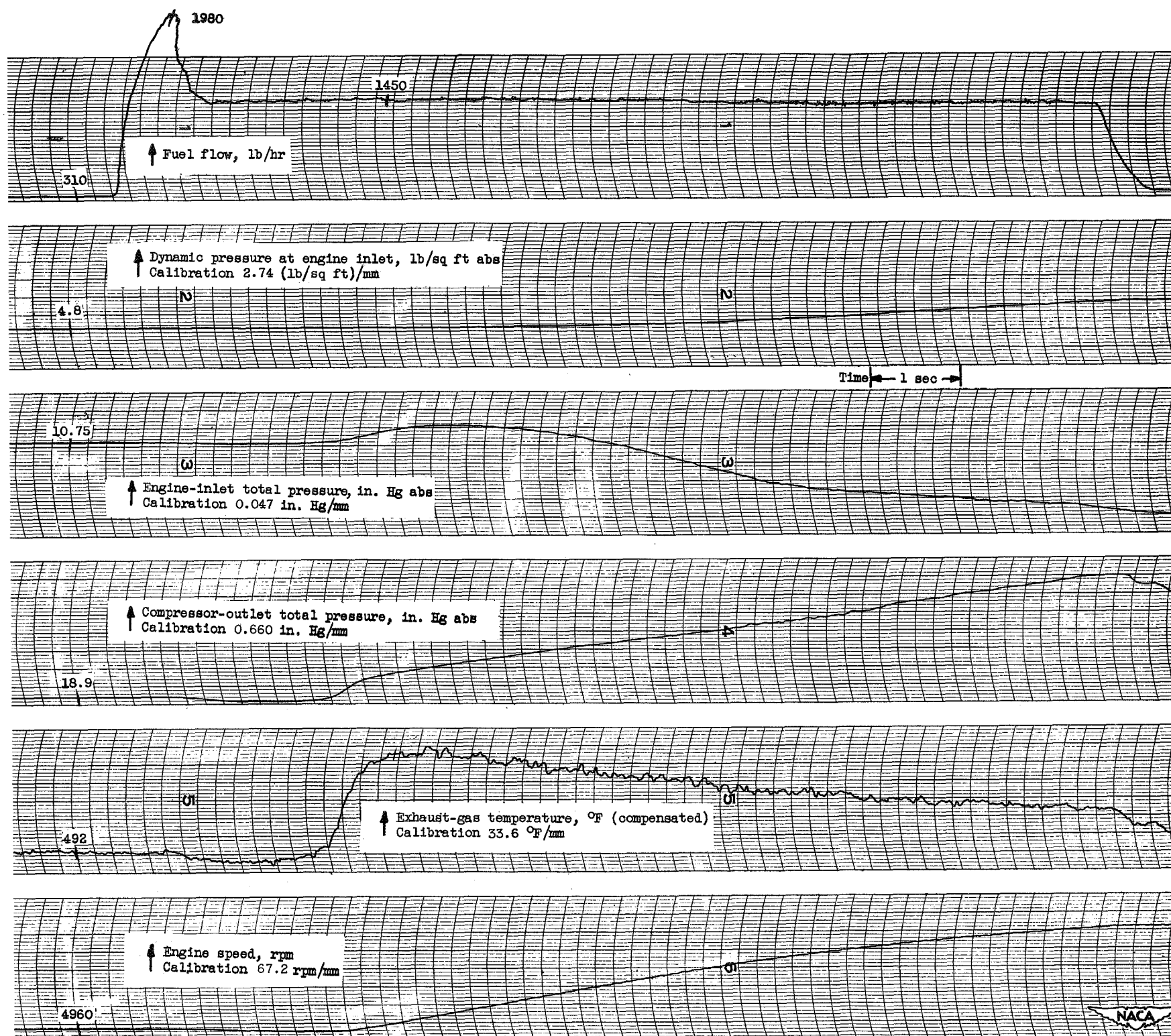


Figure 85
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 147° F; inlet guide vanes position, open.

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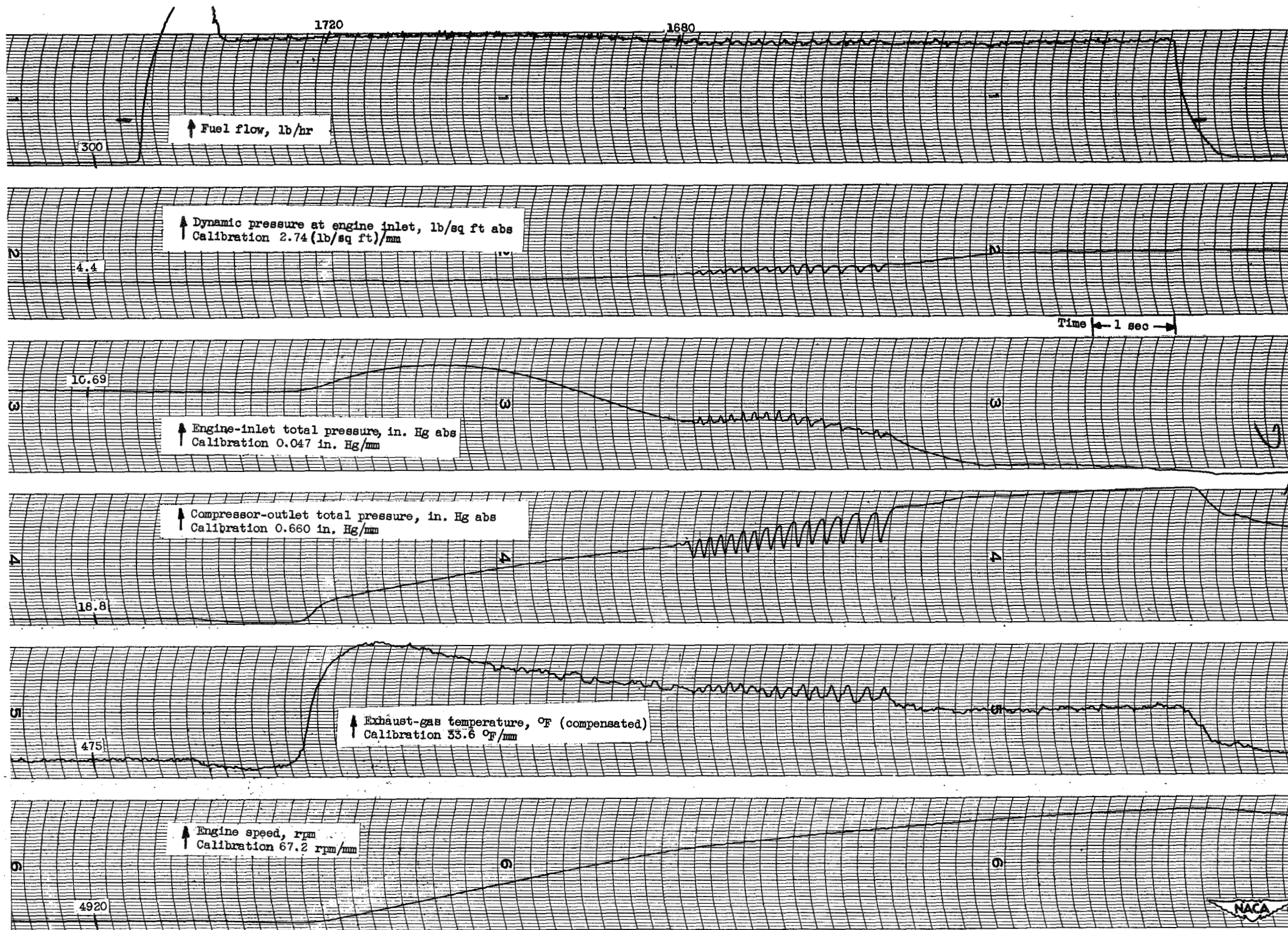


Figure 86
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 150° F; inlet guide vanes position, open.

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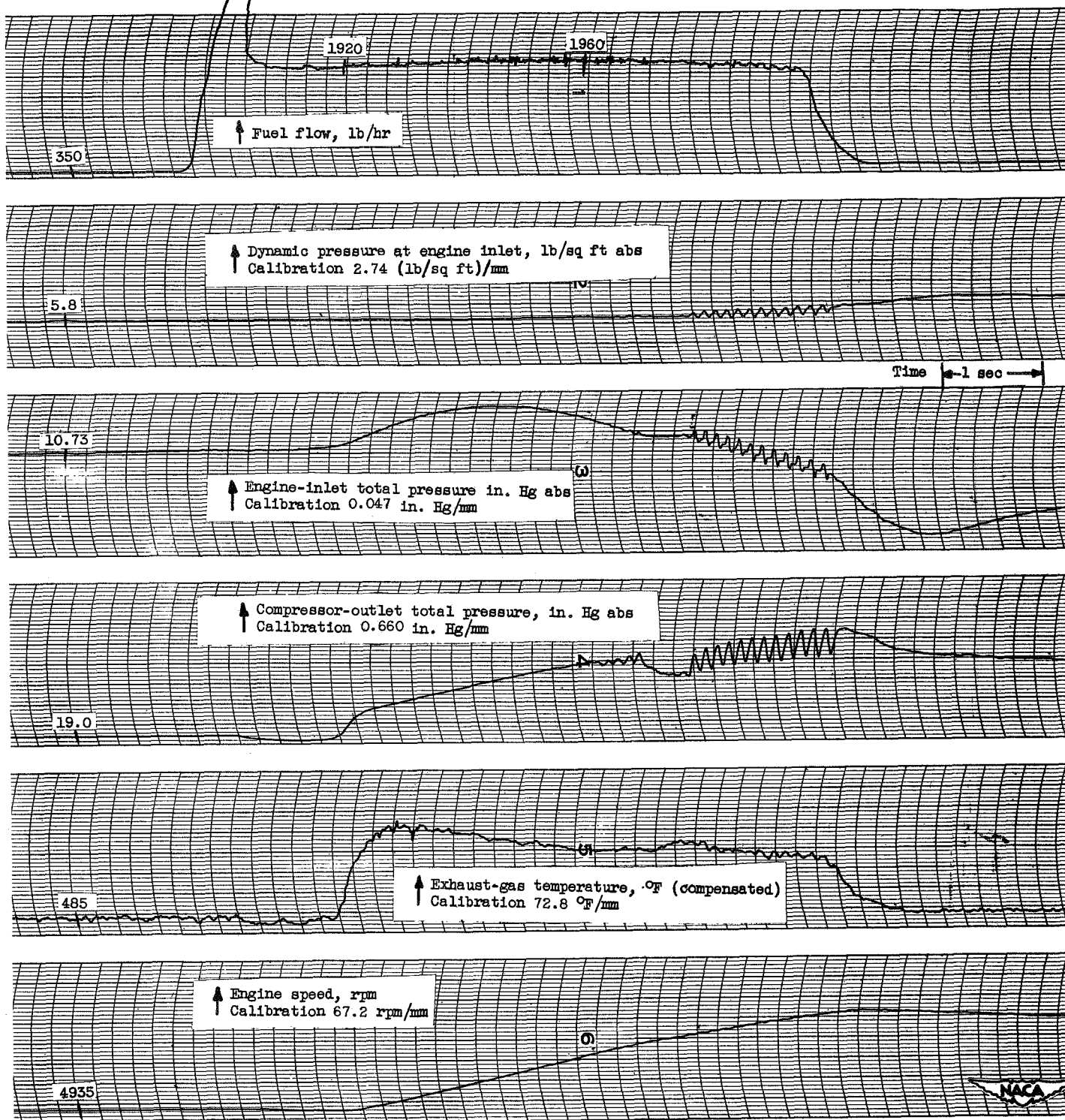


Figure 87

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 152° F; inlet guide vanes position, open.

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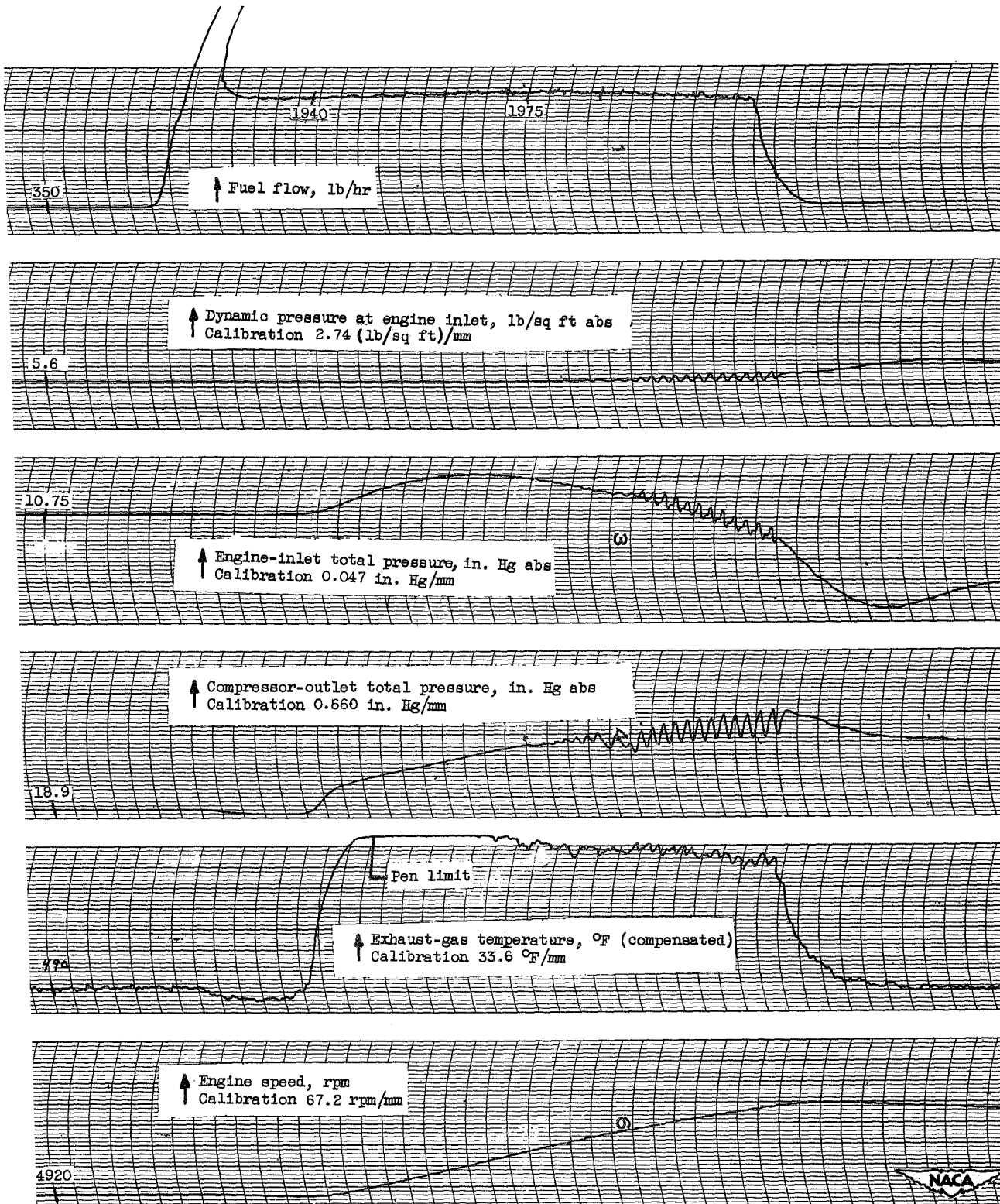


Figure 88
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 152° F; inlet guide vanes position, open.

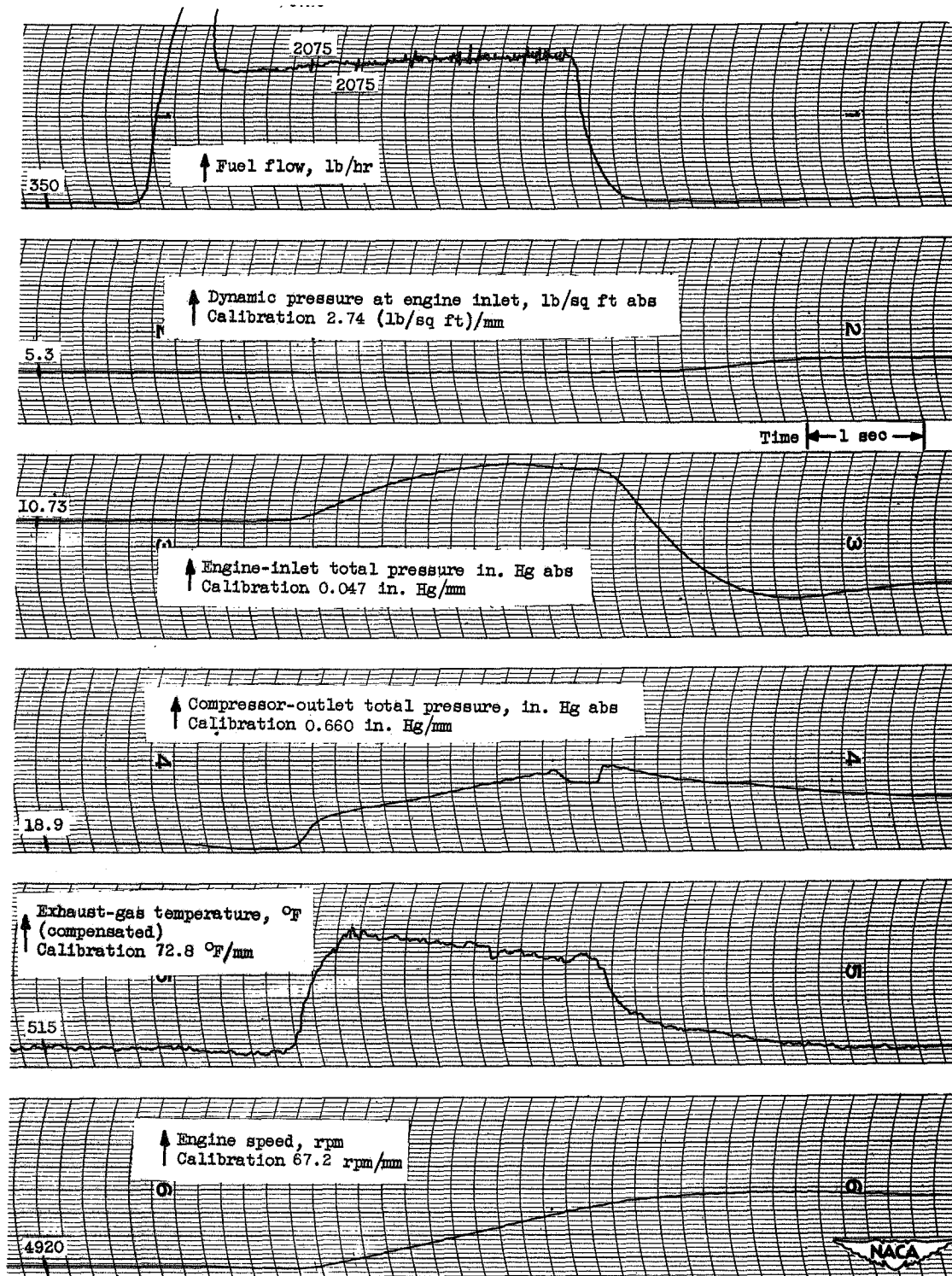


Figure 89
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 152° F; inlet guide vanes position, open.

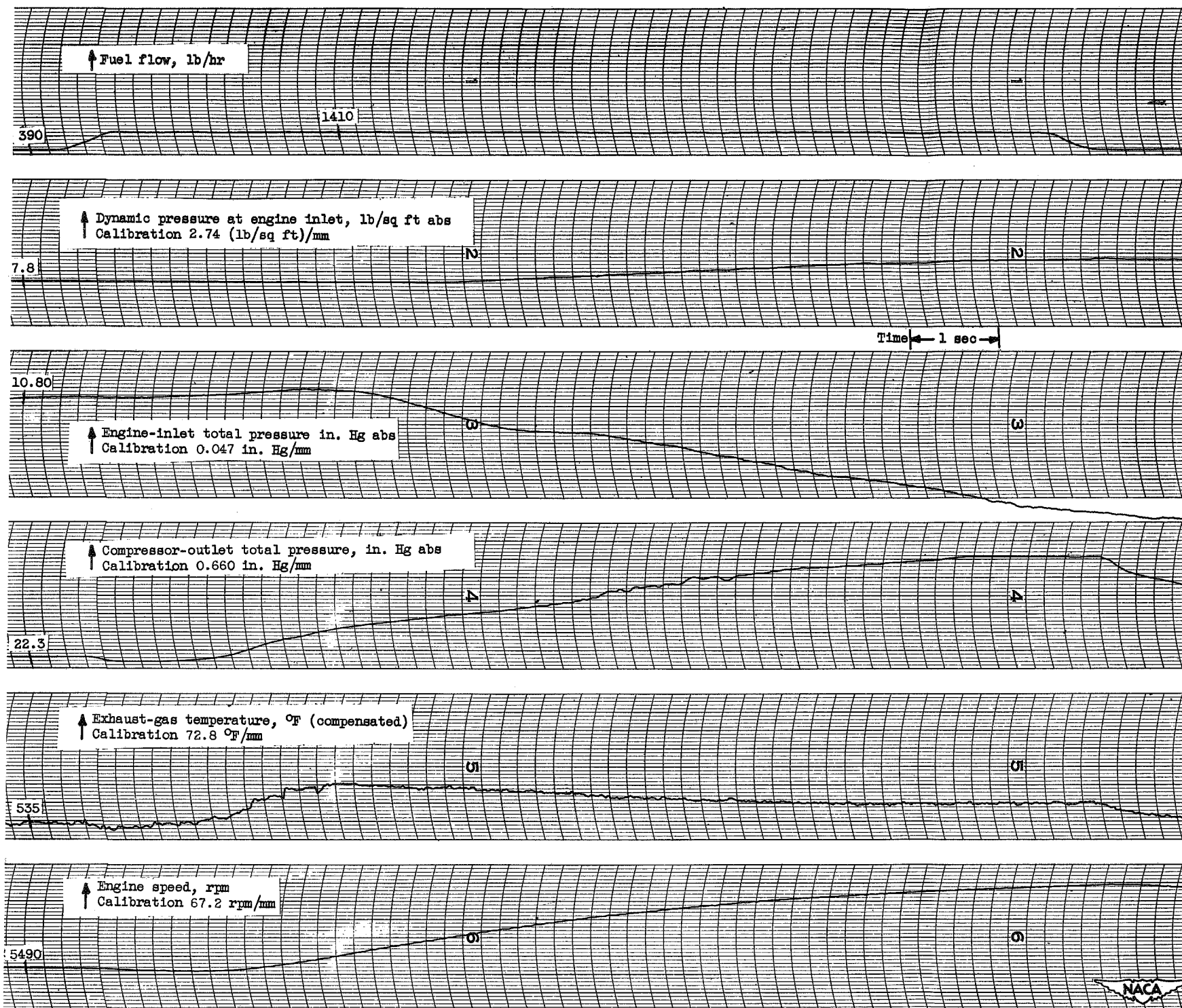


Figure 90
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 161° F; inlet guide vanes position, open.

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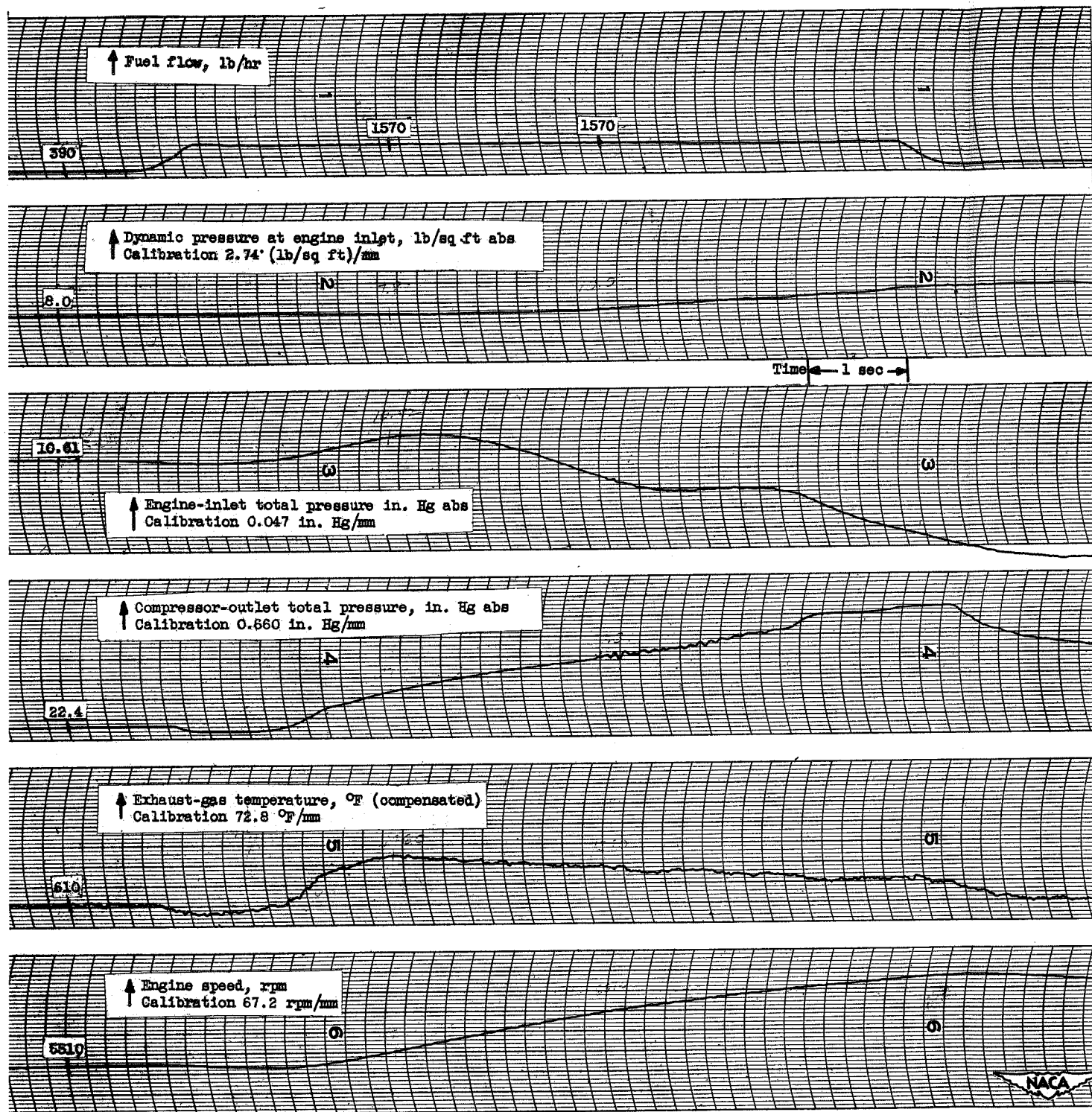


Figure 91
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 161° F; inlet guide vanes position, open.

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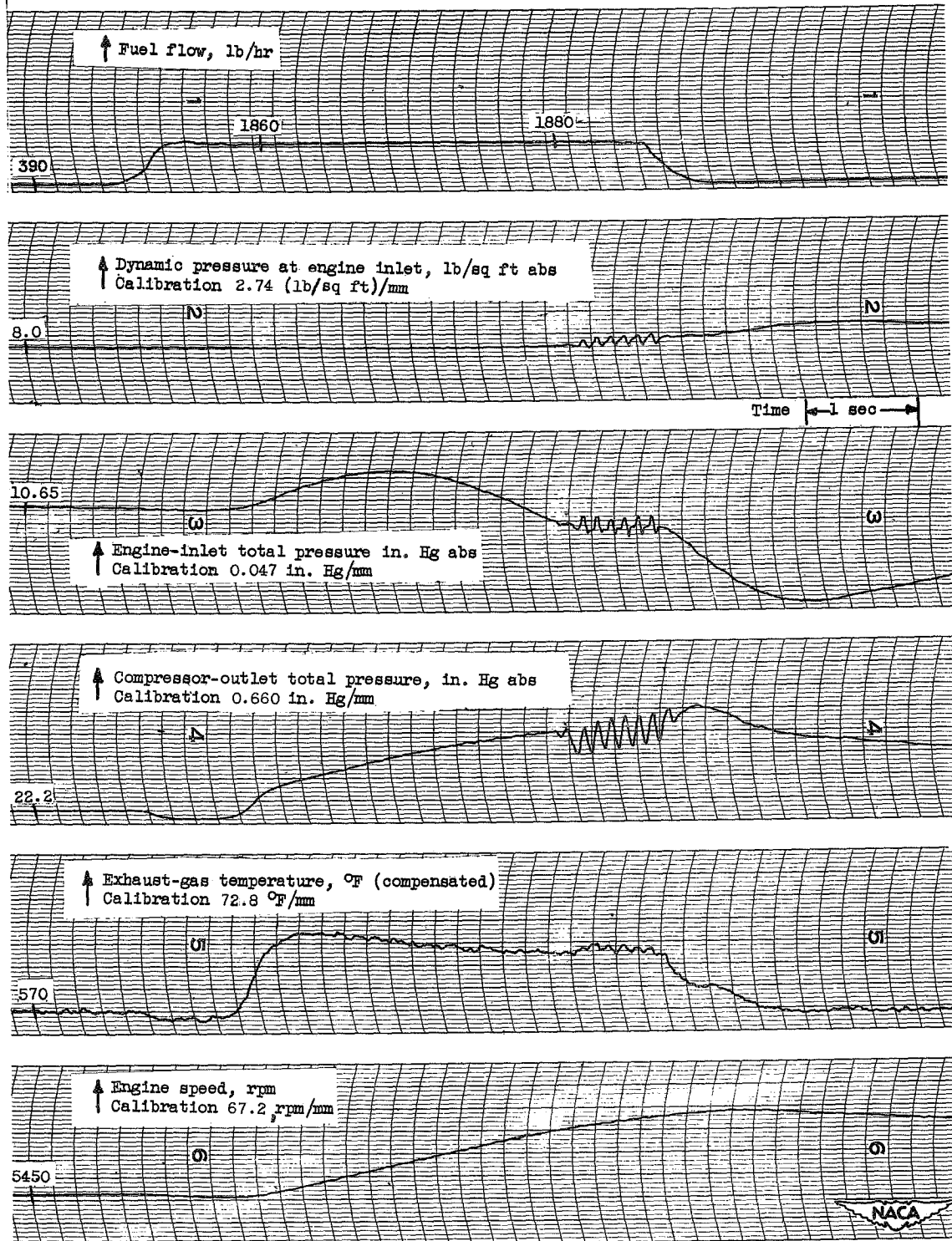


Figure 92
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 161° F; inlet guide vanes position, open.

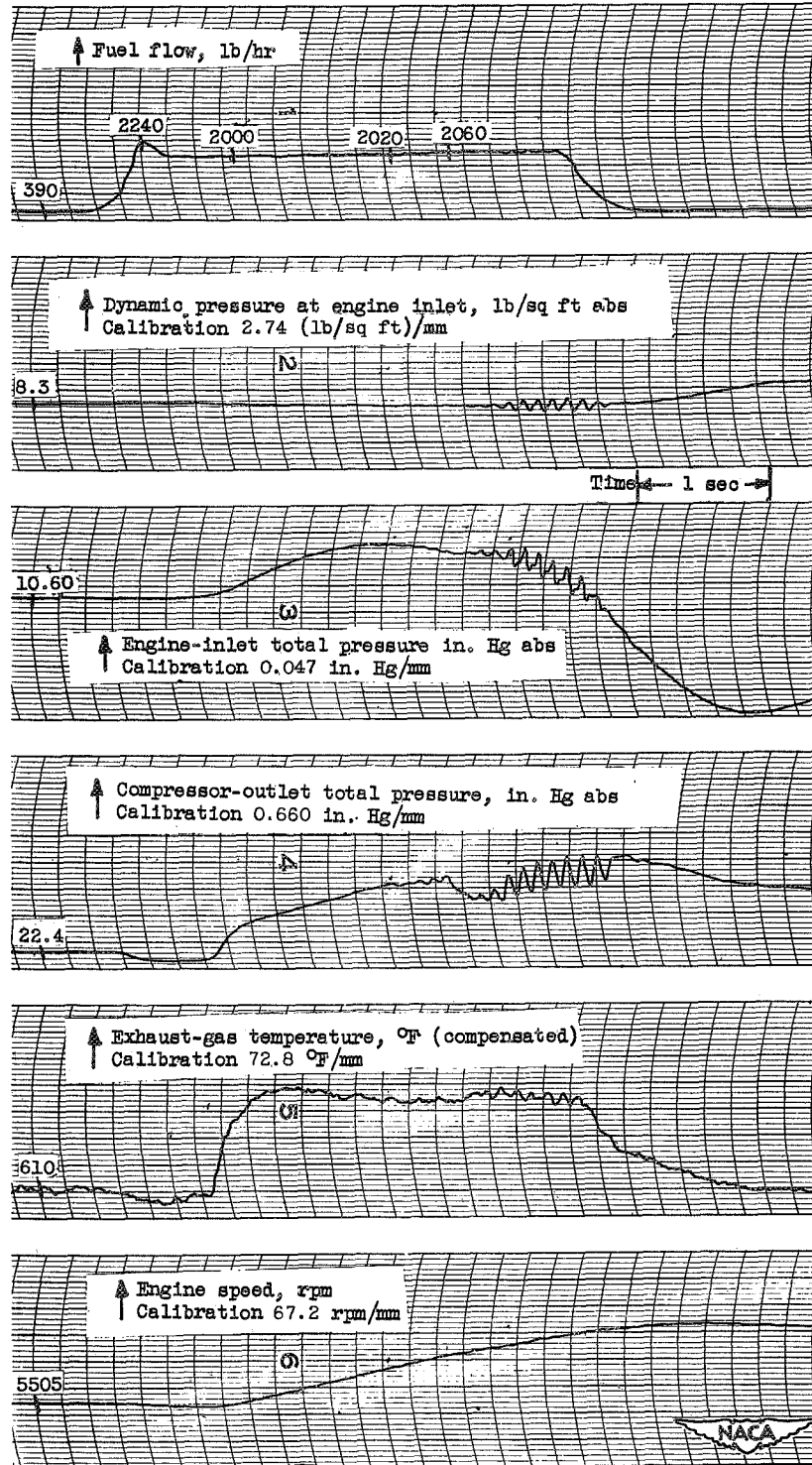


Figure 93

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 161° F; inlet guide vanes position, open.

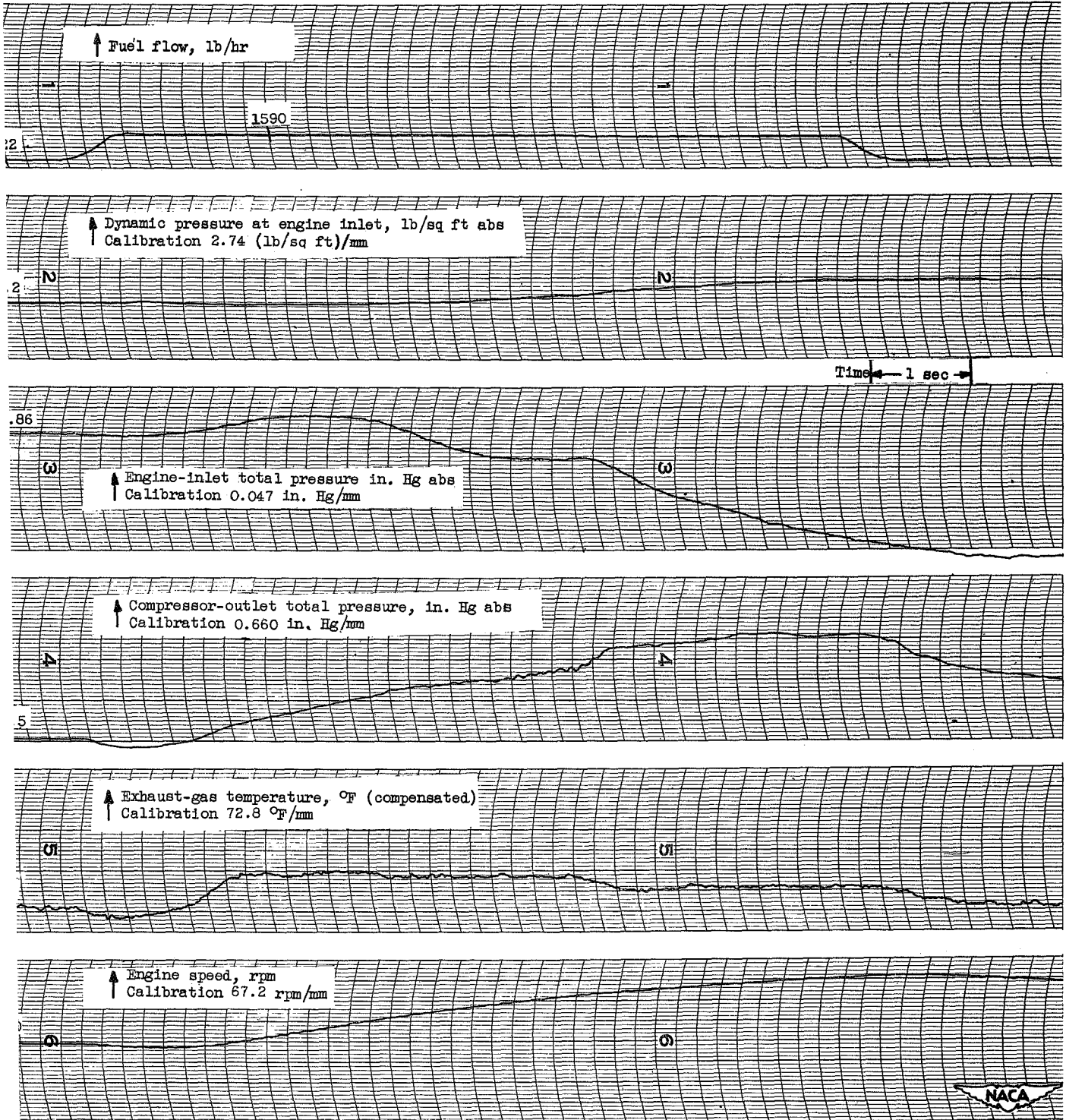


Figure 94
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 163° F; inlet guide vanes position, open.

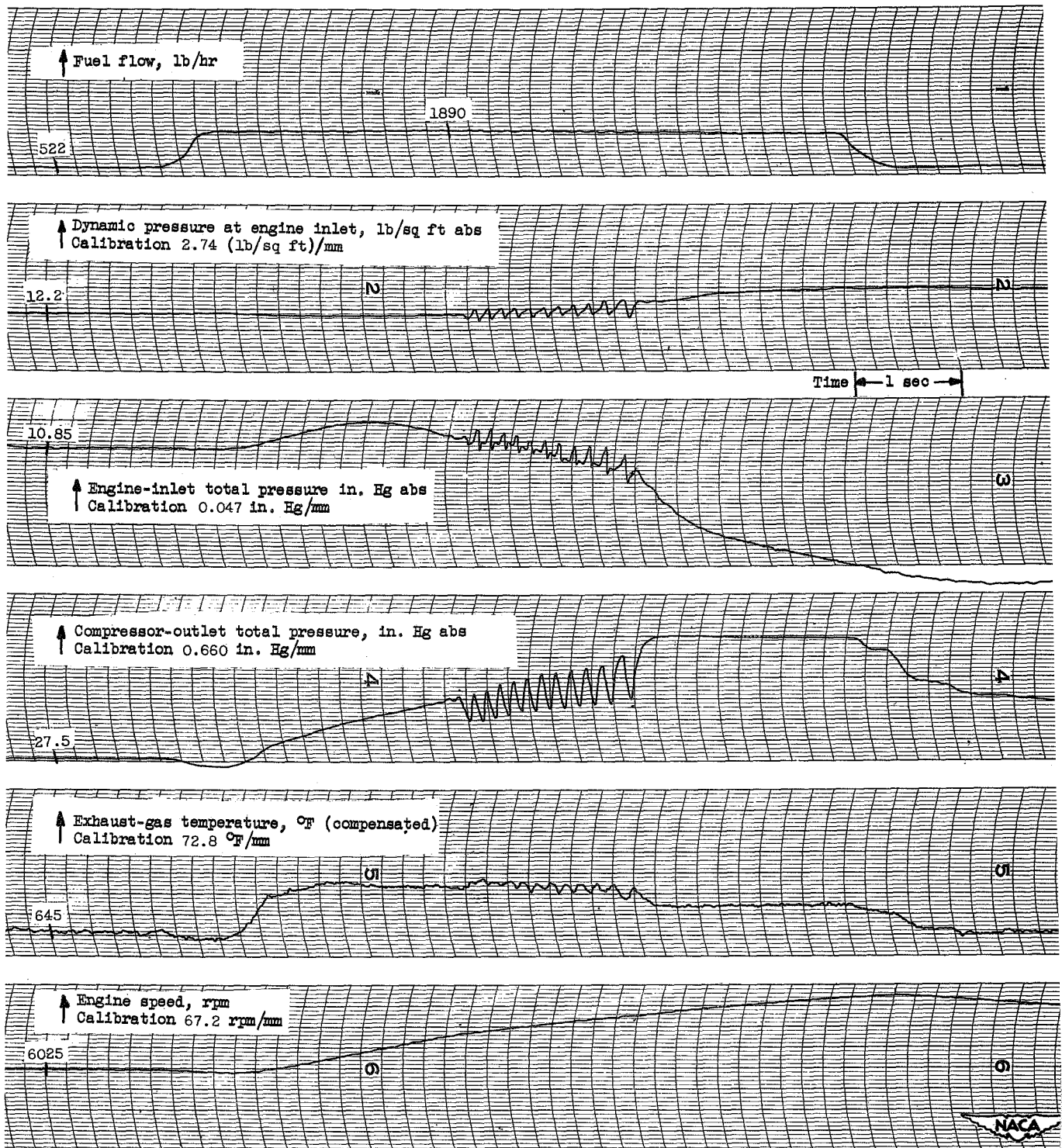


Figure 95

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 163° F; inlet guide vanes position, open.

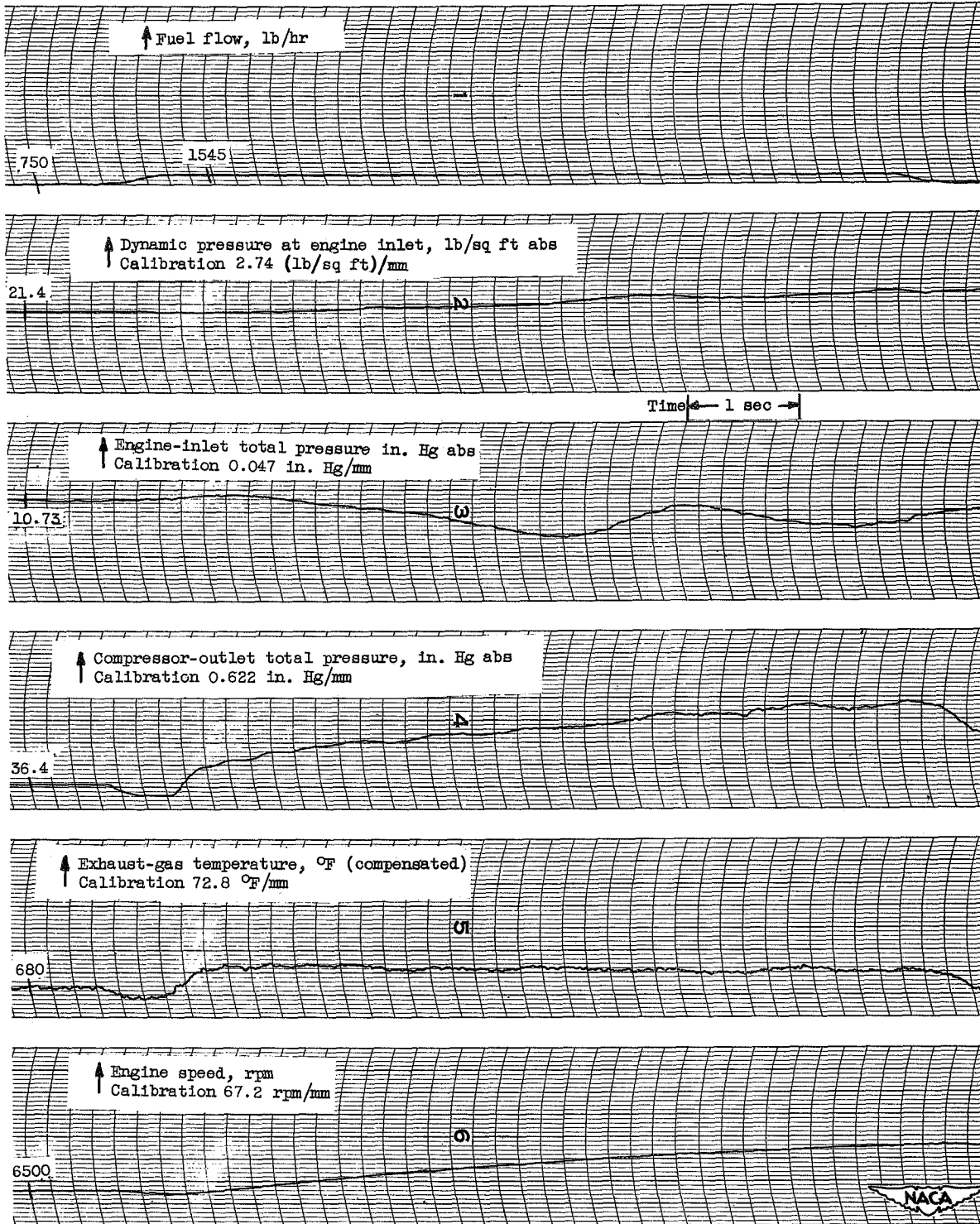


Figure 96

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 164° F; inlet guide vanes position, open.

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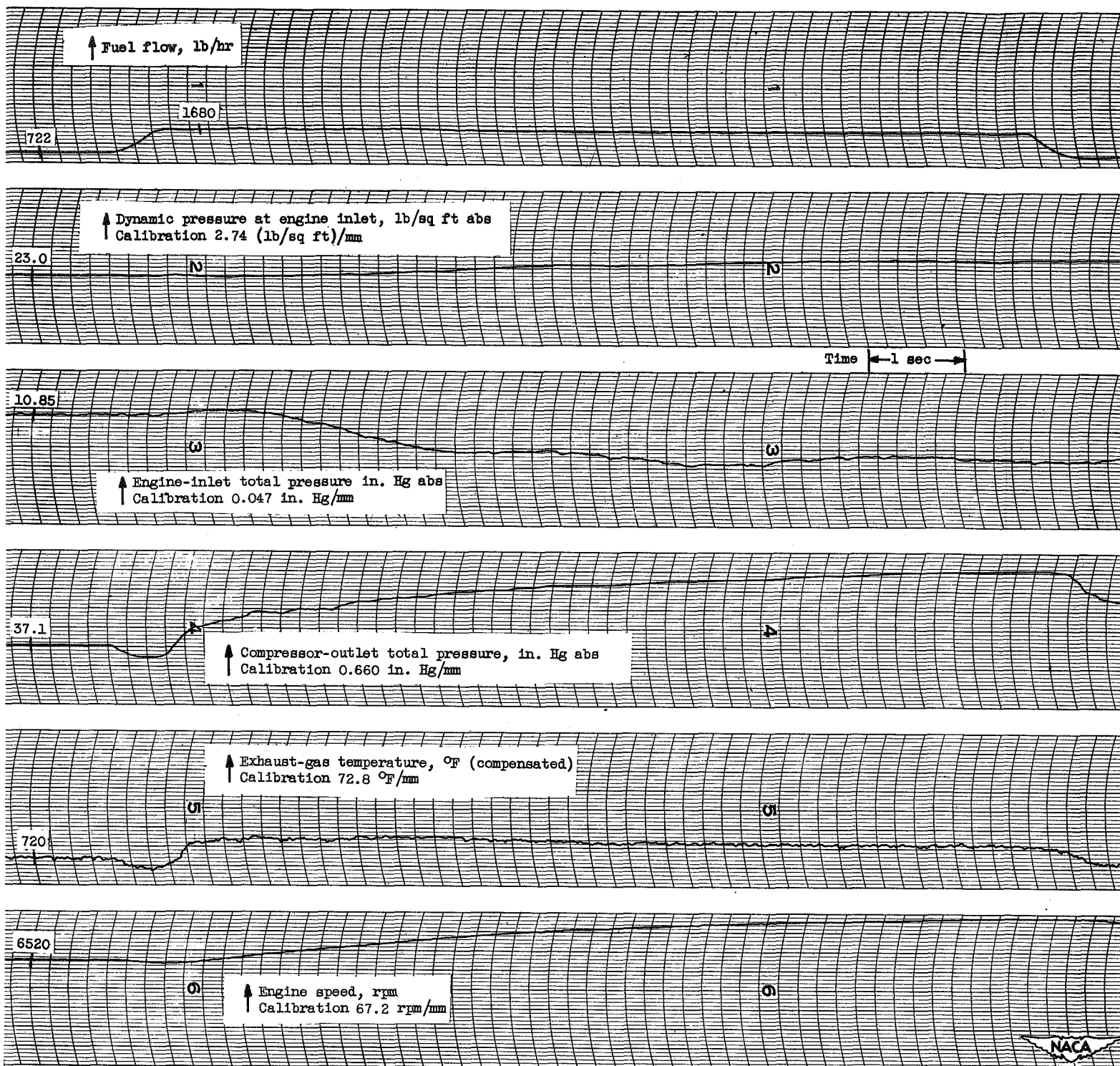


Figure 97

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 165° F; inlet guide vanes position, open.

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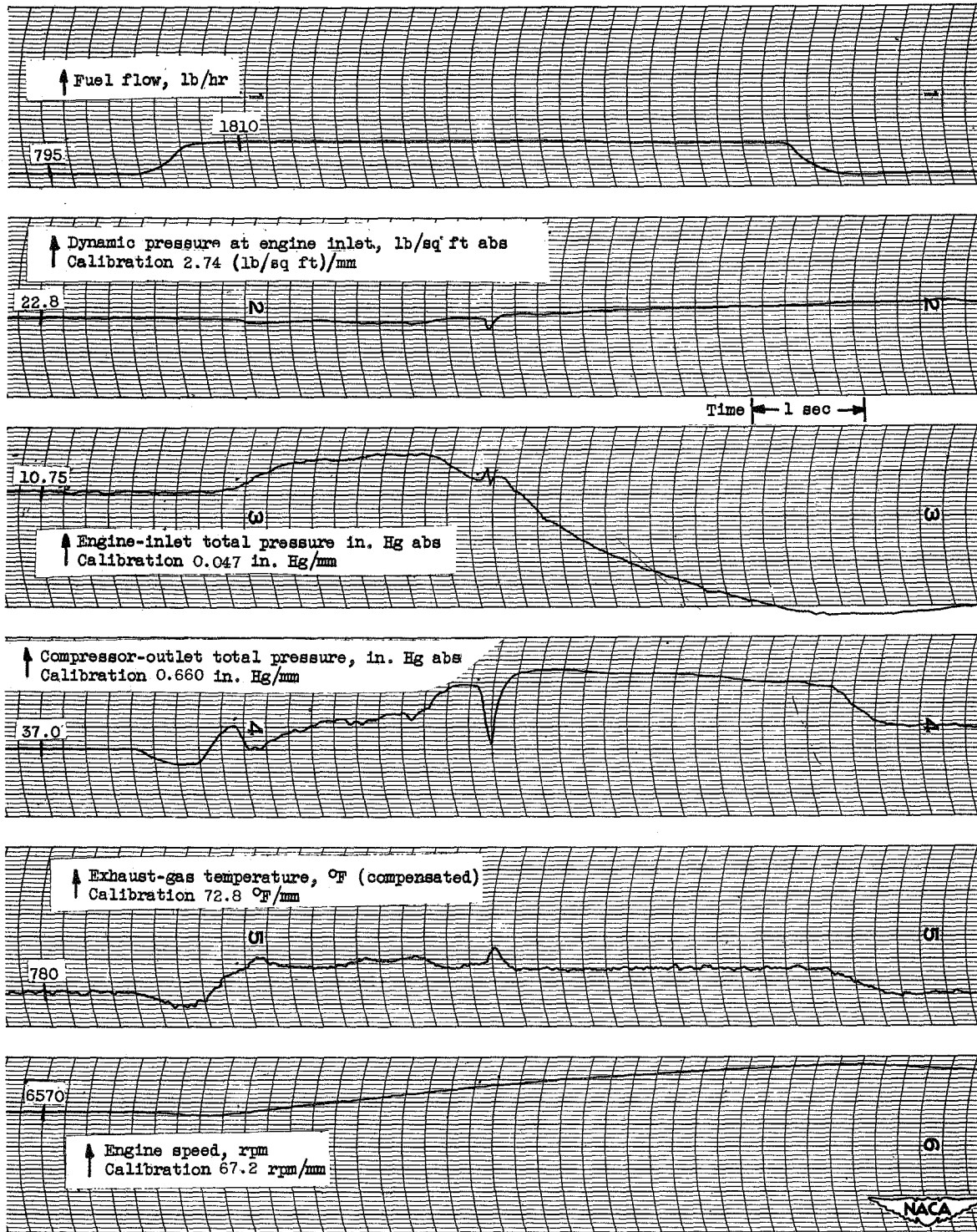


Figure 98

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 165° F; inlet guide vanes position, open.

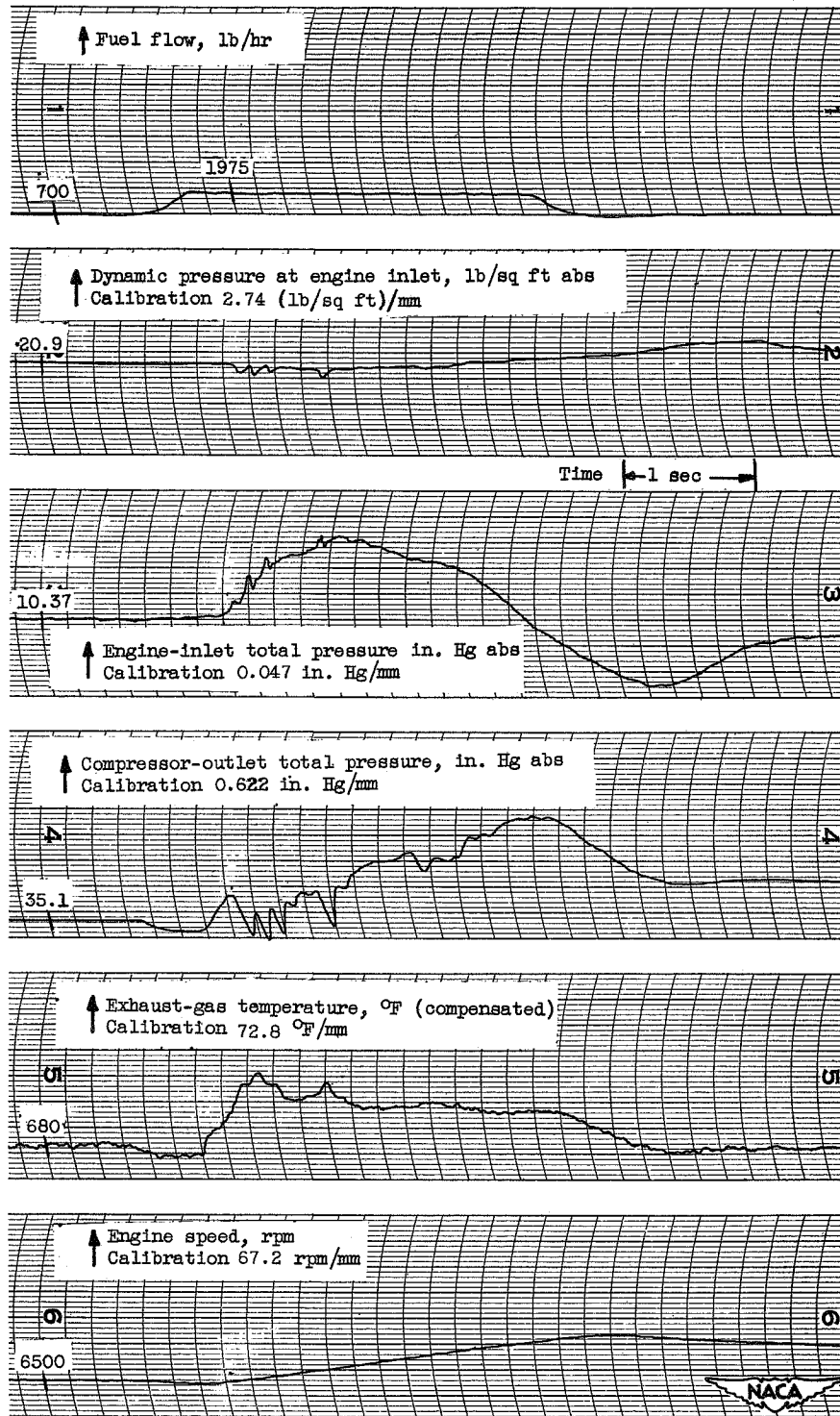


Figure 99

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 164° F; inlet guide vanes position, open.

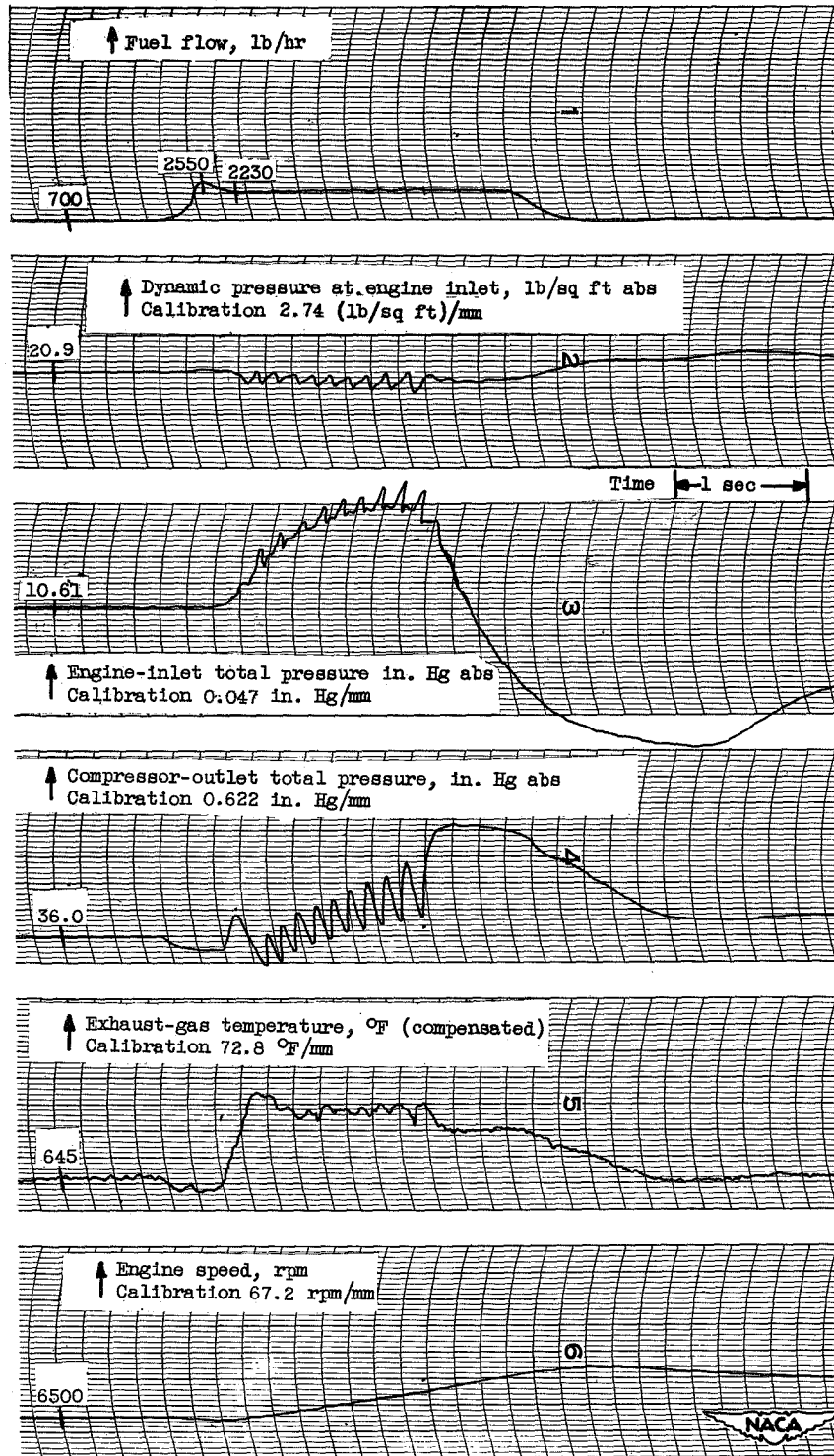


Figure 100
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 164° F; inlet guide vanes position, open.

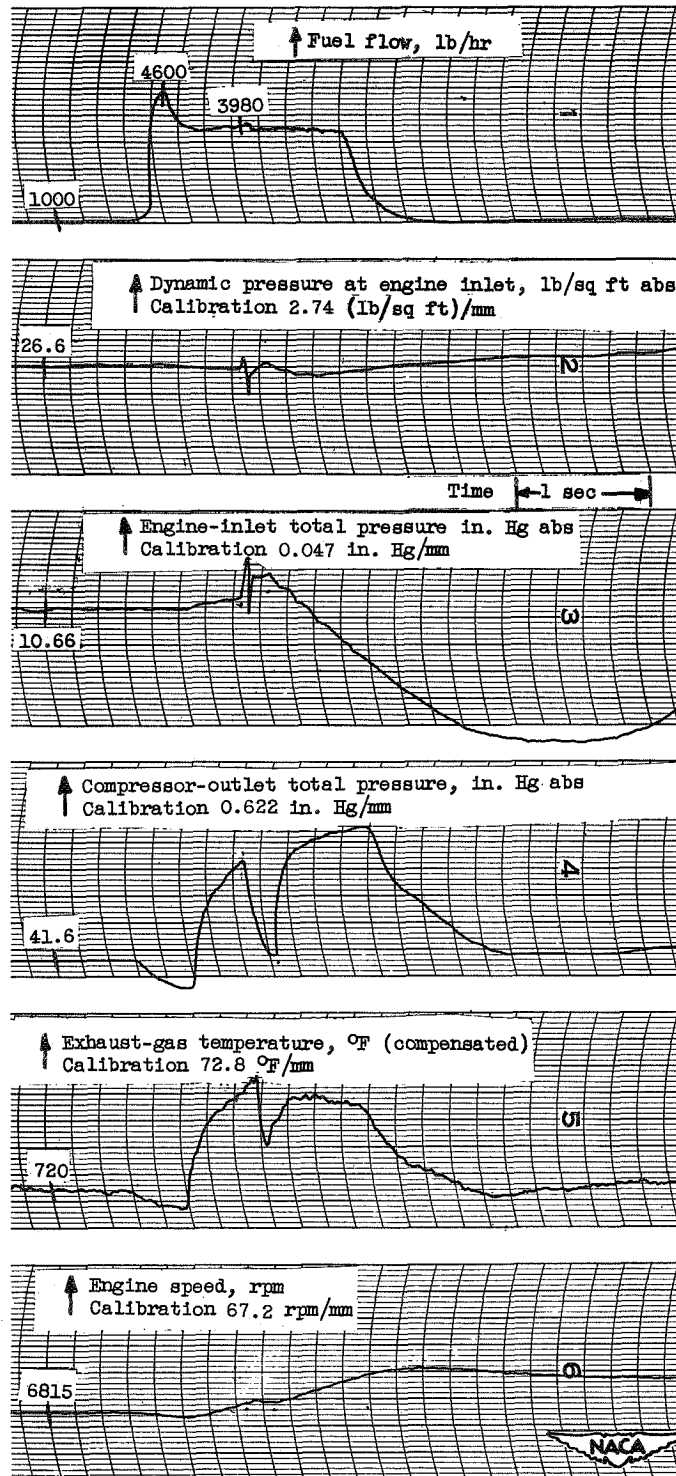


Figure 101

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 163° F; inlet guide vanes position, open.

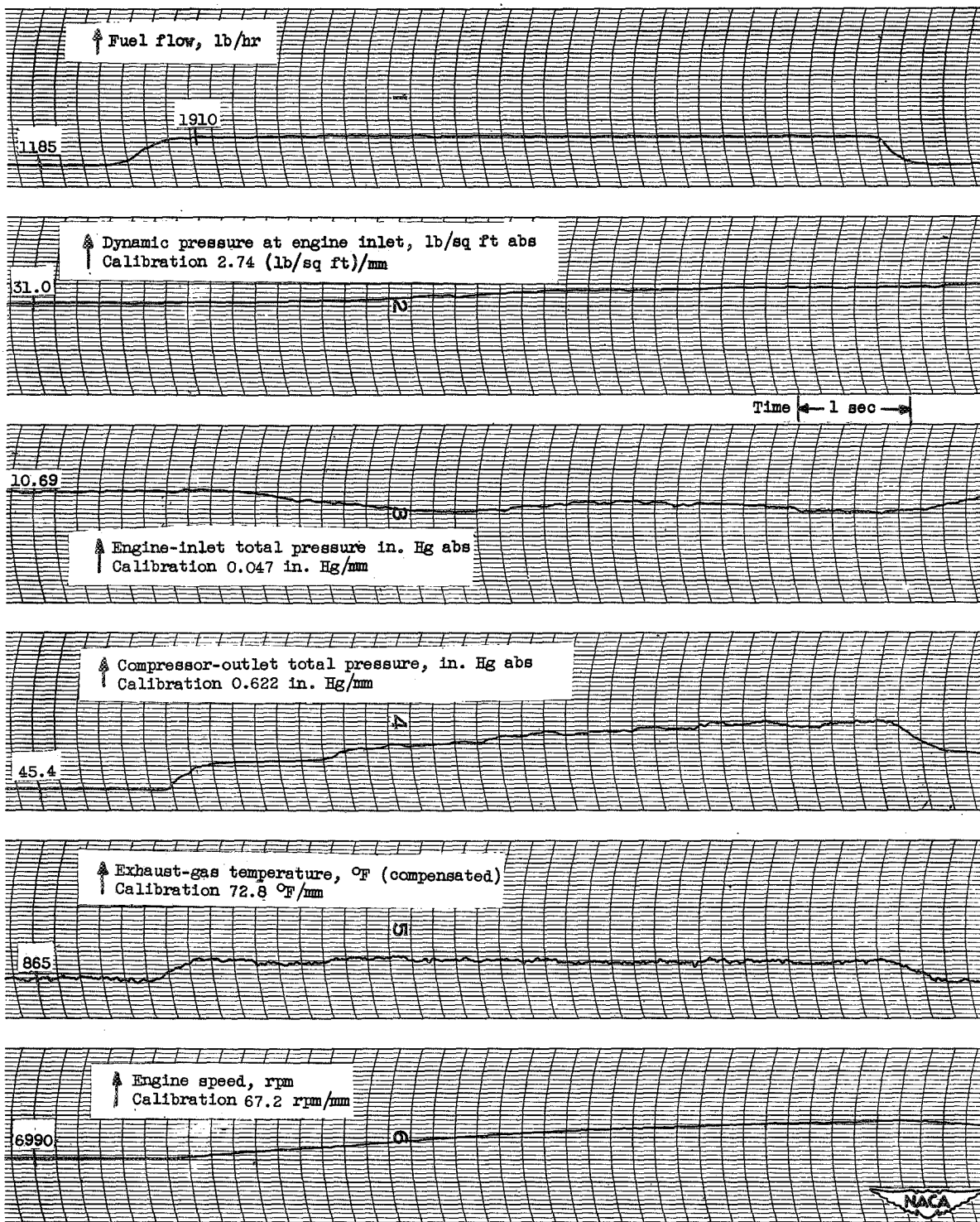


Figure 102
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 166° F; inlet guide vanes position, open.

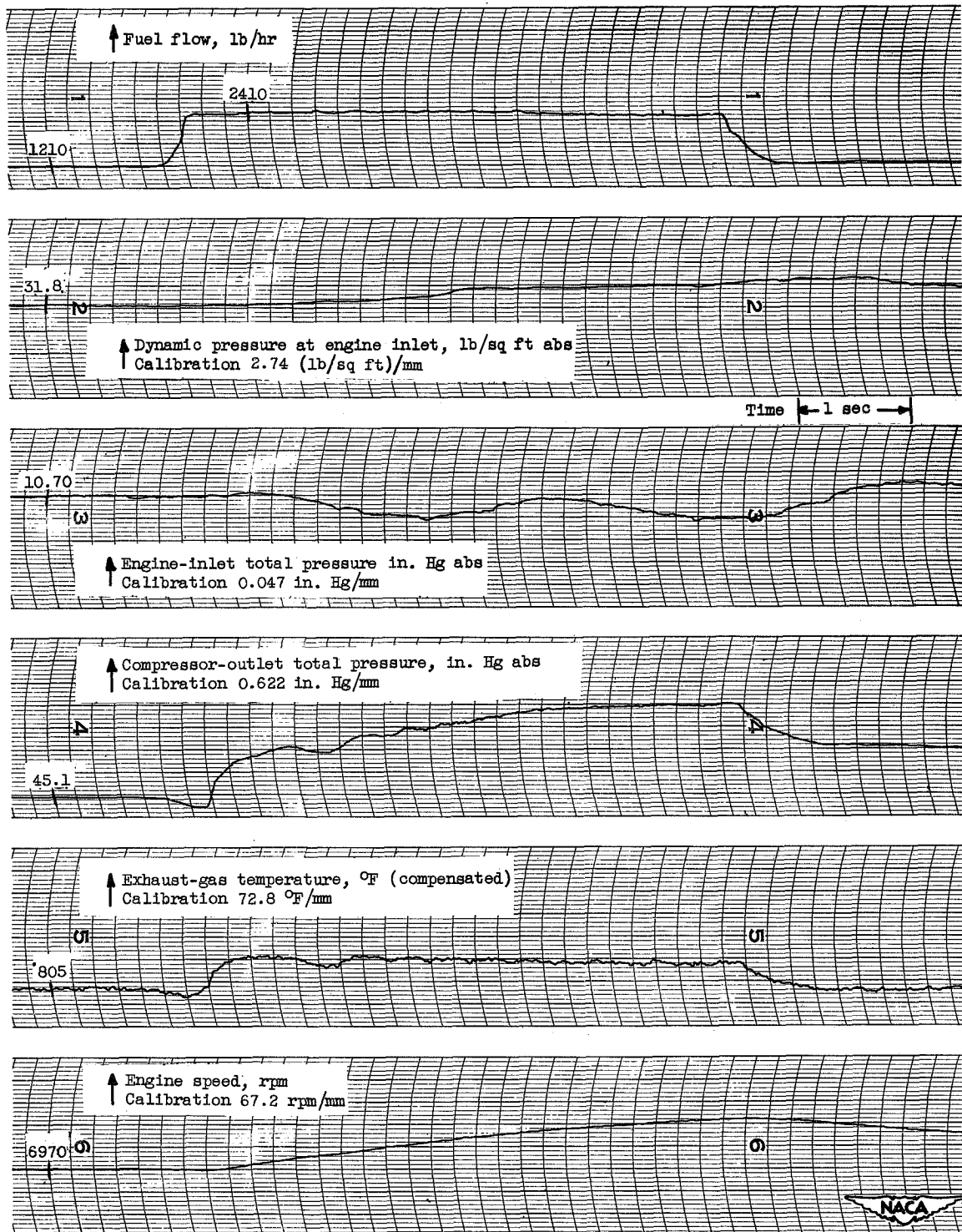


Figure 103

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 166° F; inlet guide vanes position, open.

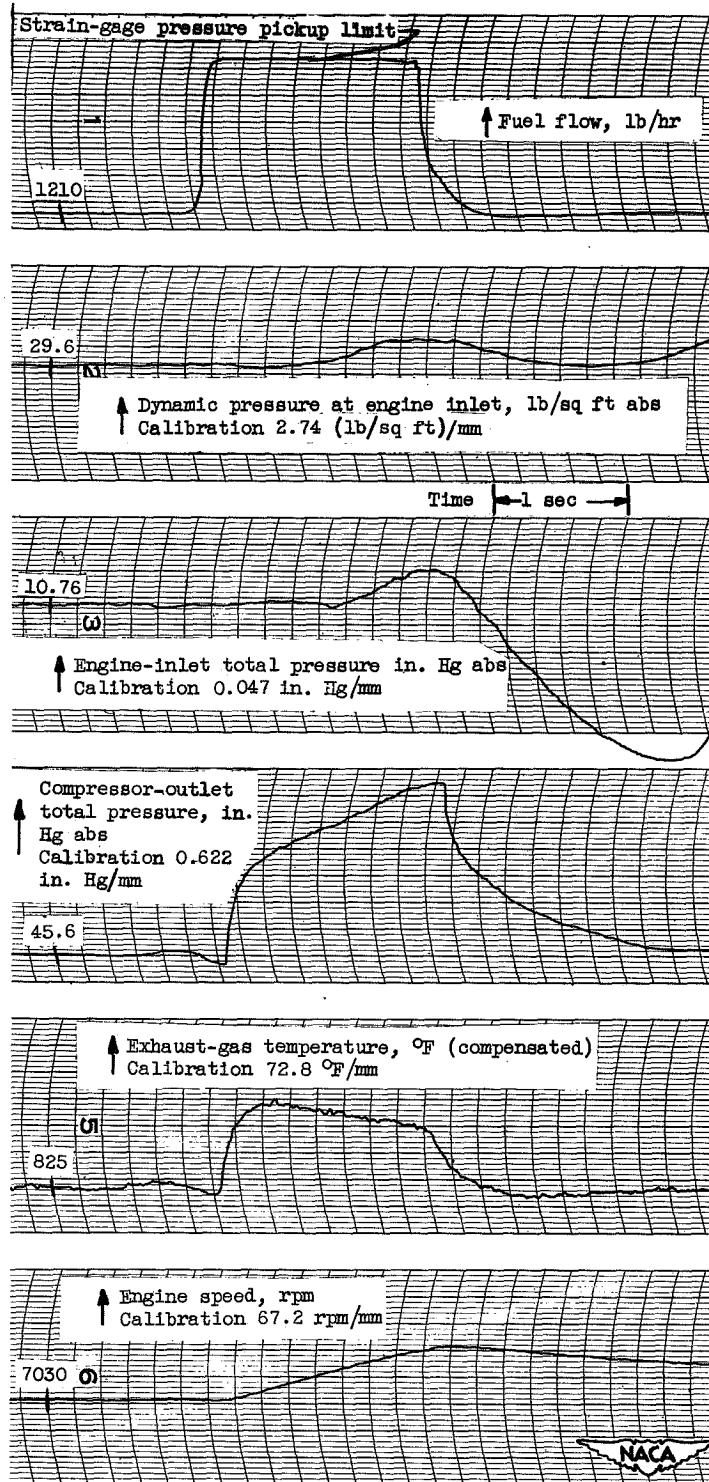


Figure 104

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 166° F; inlet guide vanes position, open.

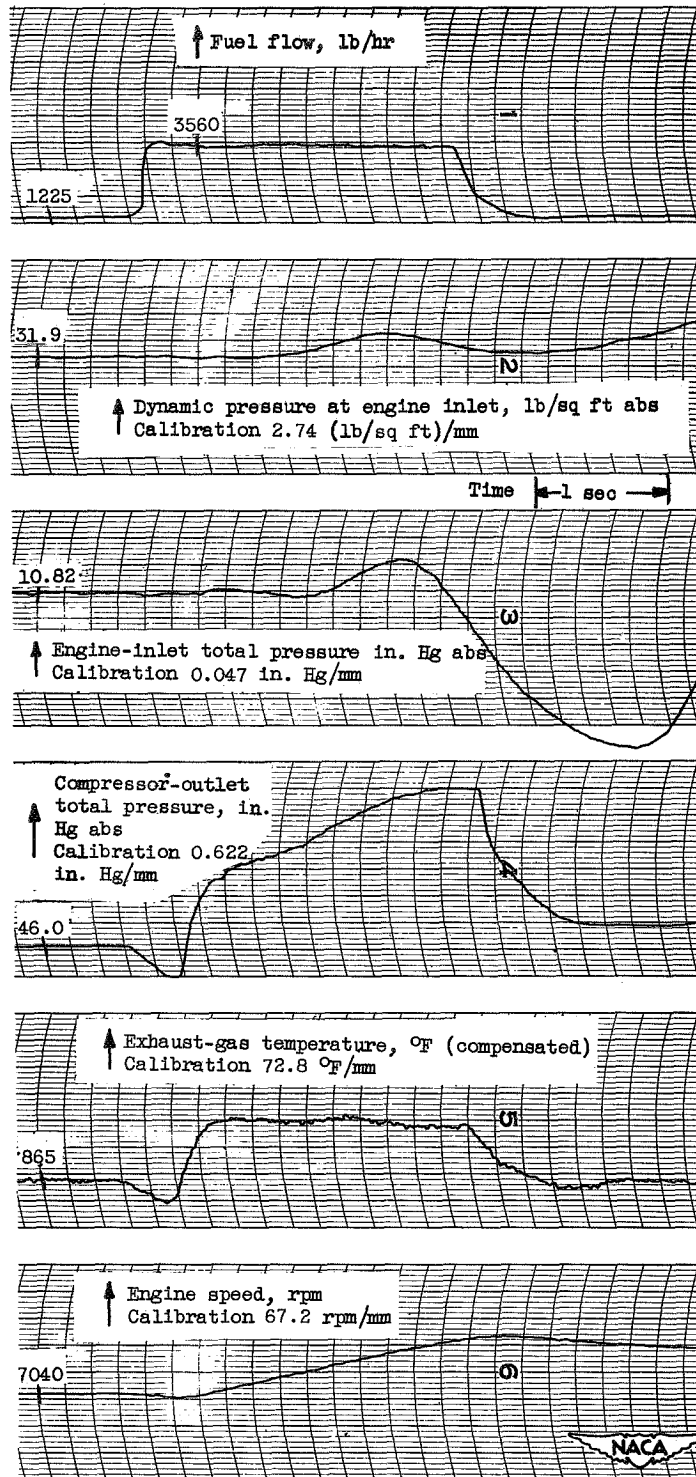


Figure 105

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 165° F; inlet guide vanes position, open.

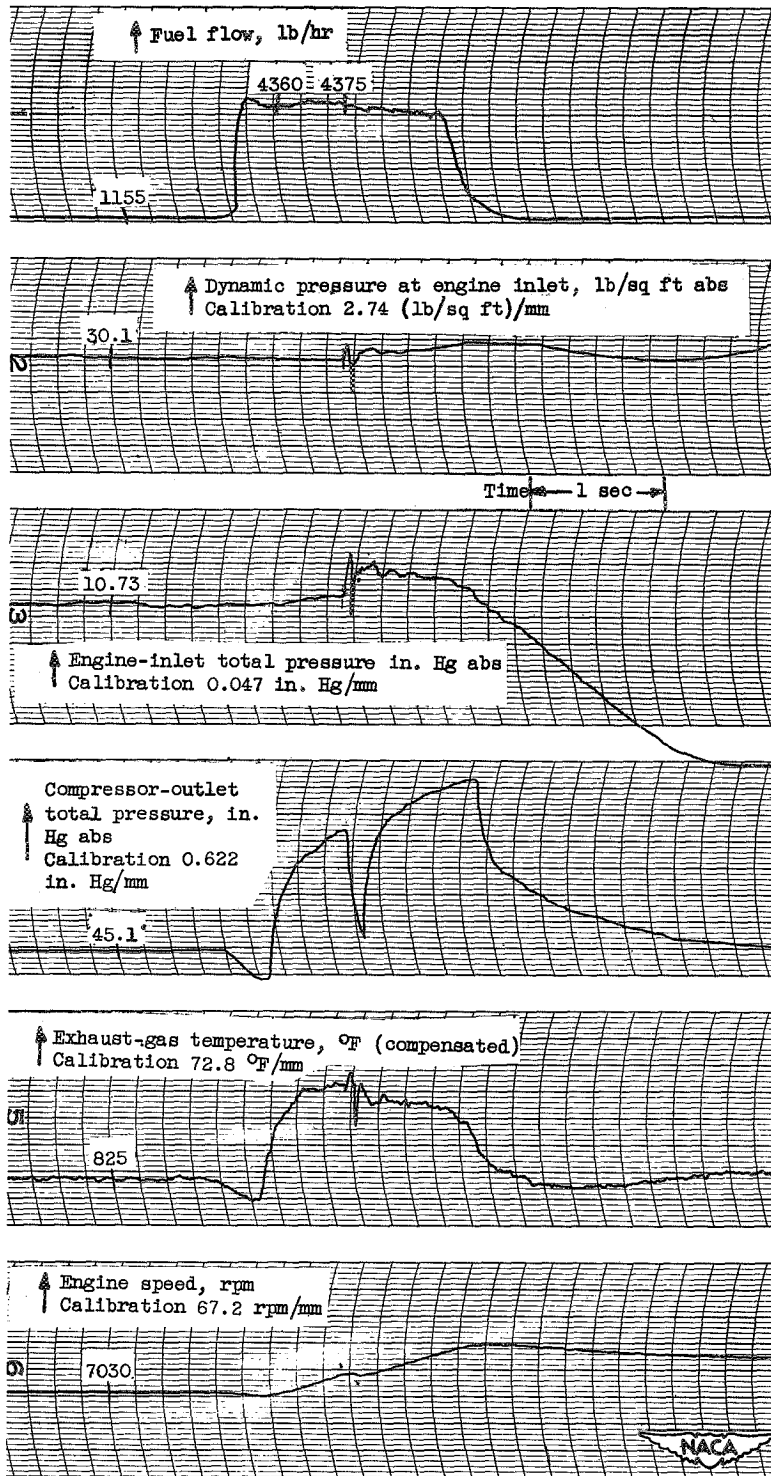


Figure 106

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 165° F; inlet guide vanes position, open.

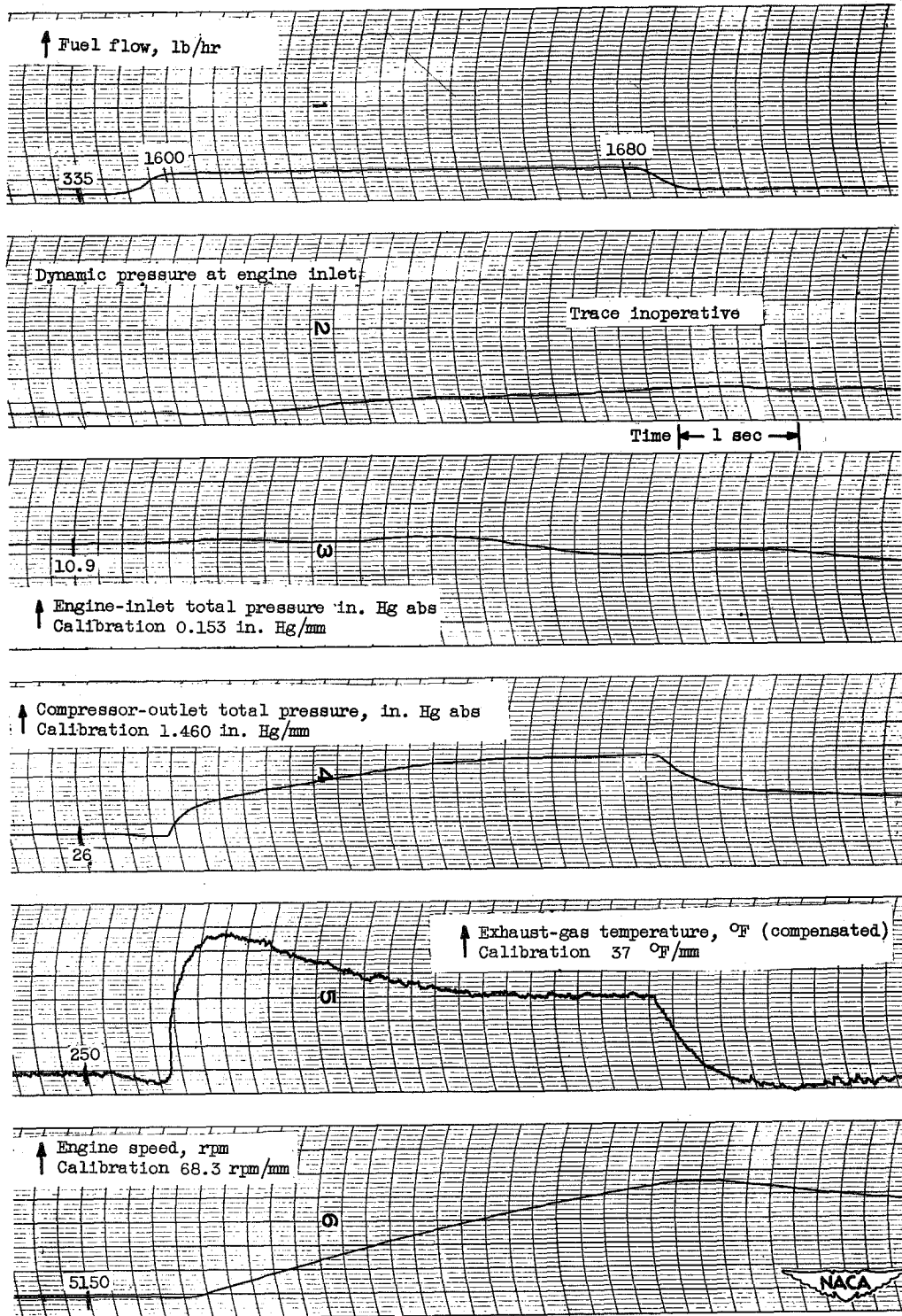


Figure 107

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 17° F; inlet guide vanes position, closed.

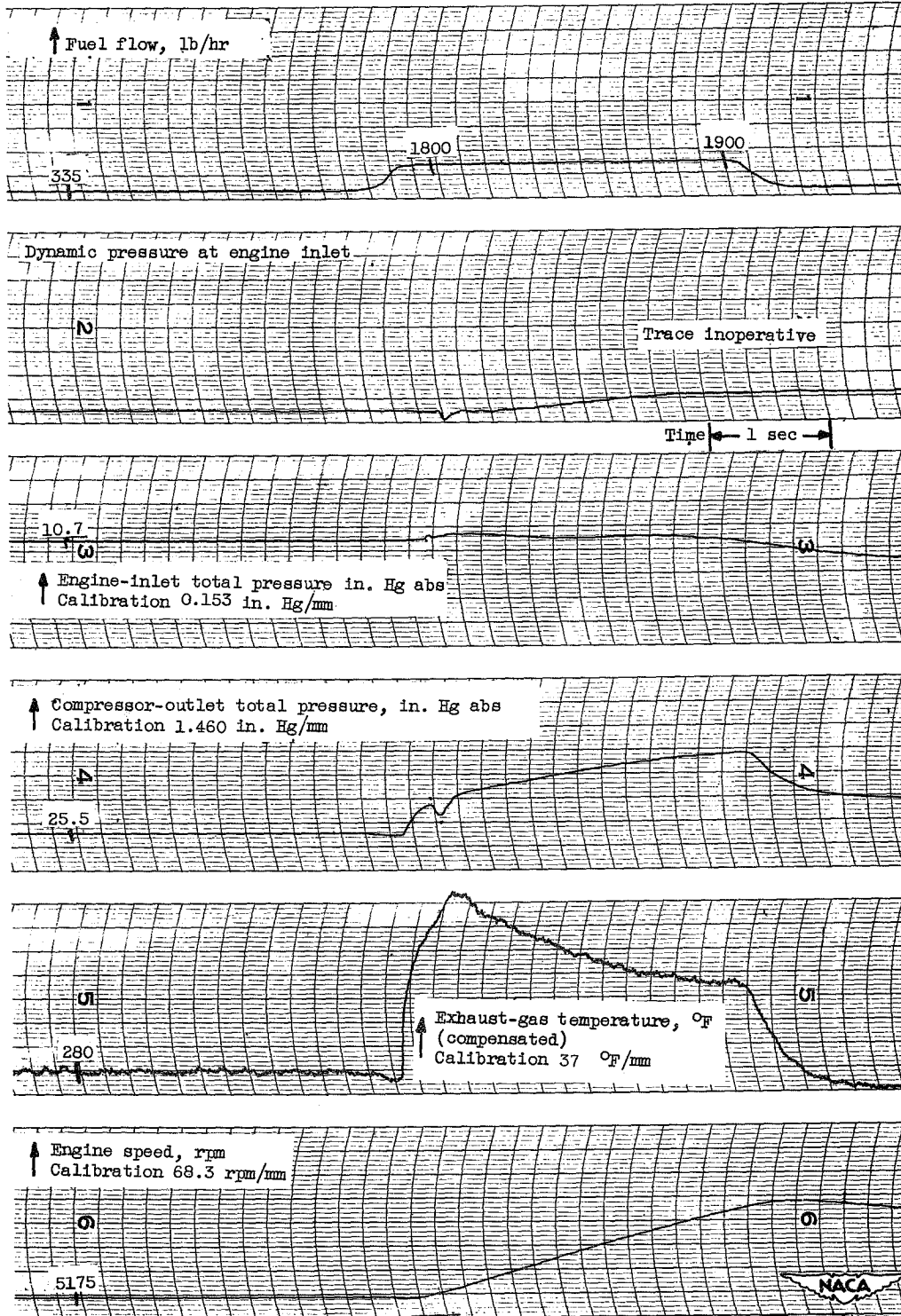


Figure 108

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 17.° F; inlet guide vanes position, closed.

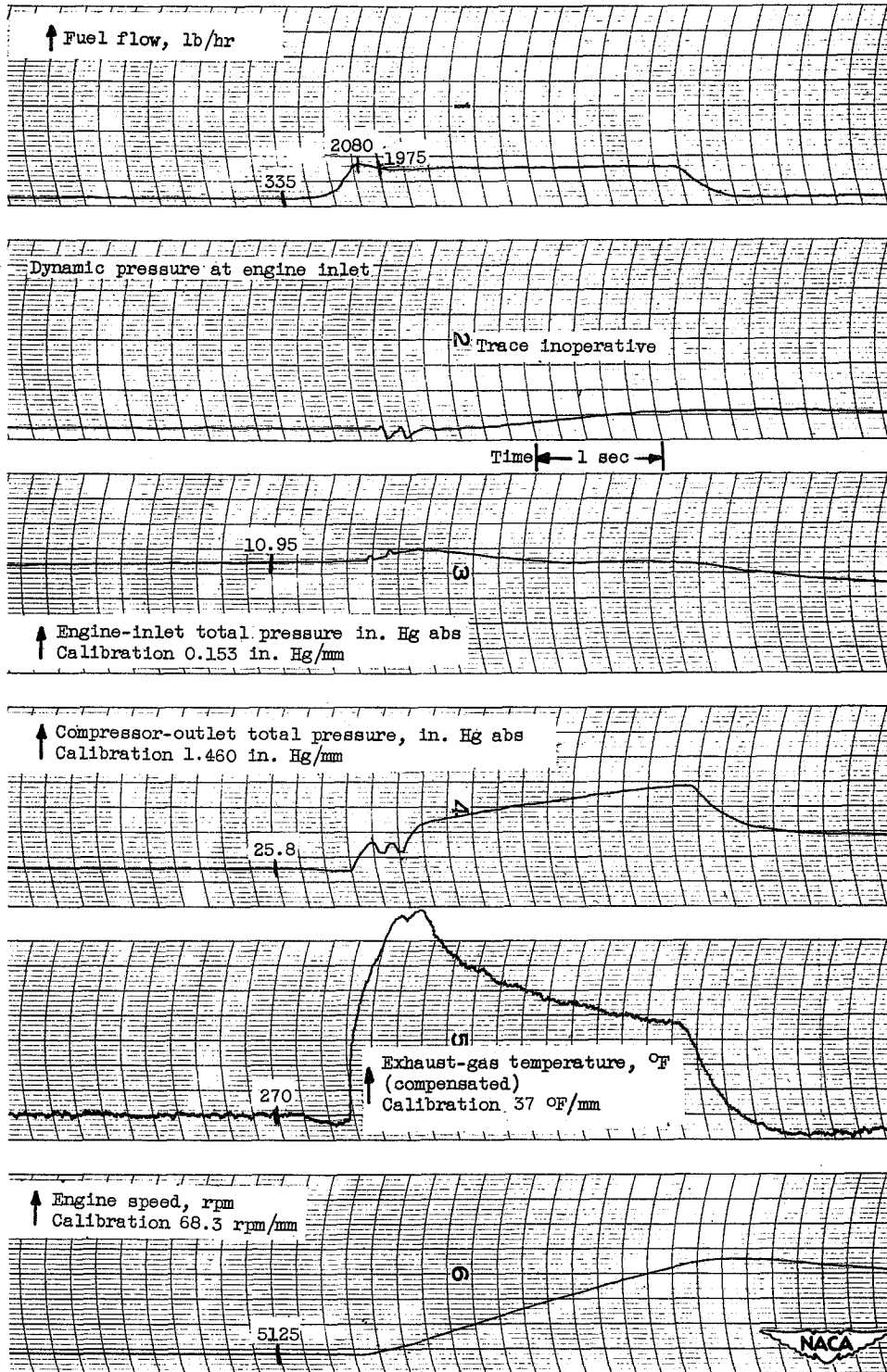


Figure 109

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 17 ° F; inlet guide vanes position, closed.

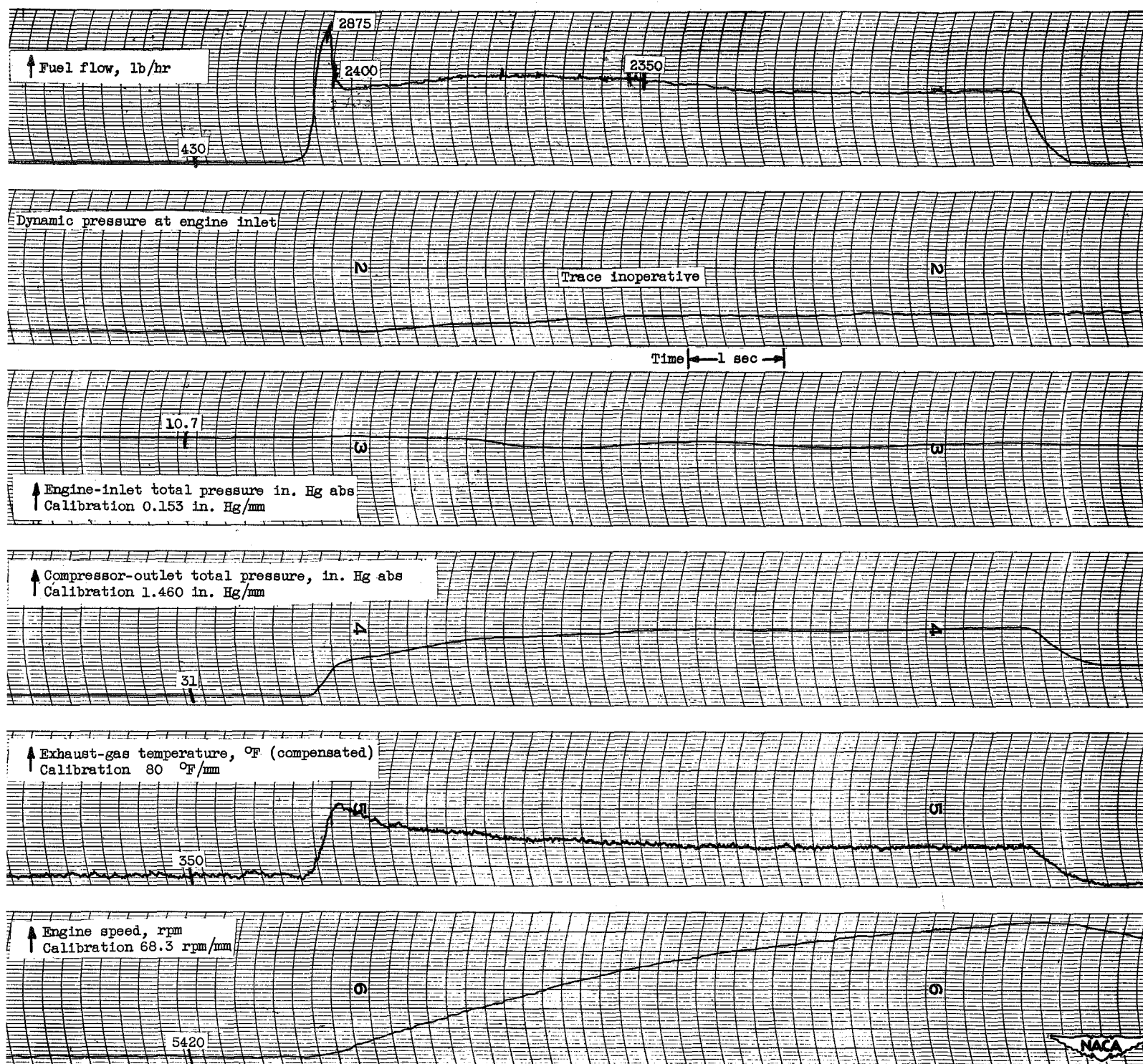


Figure 110

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -2°F ; inlet guide vanes position, closed.

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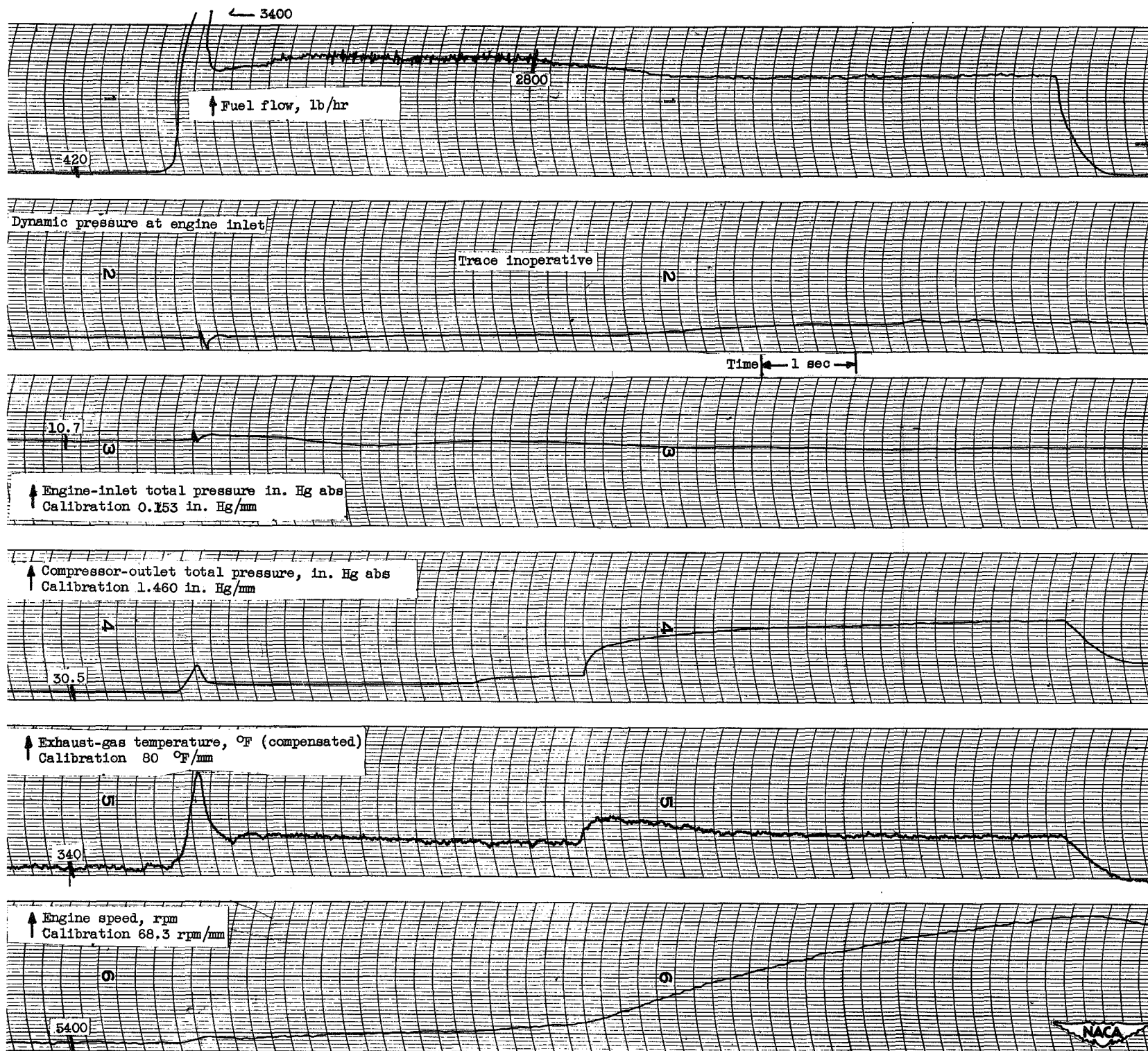


Figure 111

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8 ; engine-inlet air temperature, -3°F ; inlet guide vanes position, closed.

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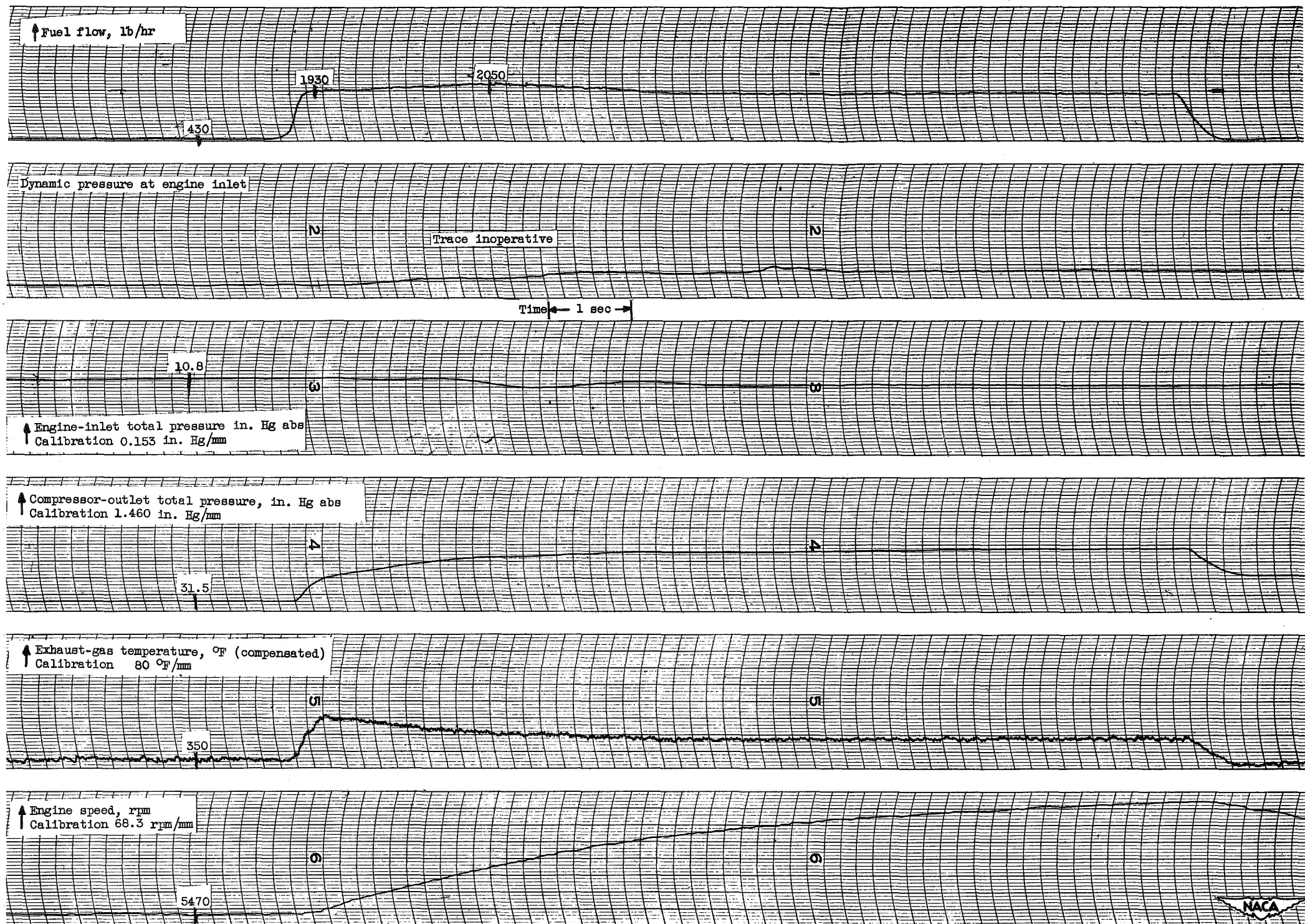


Figure 112

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, -2 °F; inlet guide vanes position, closed.

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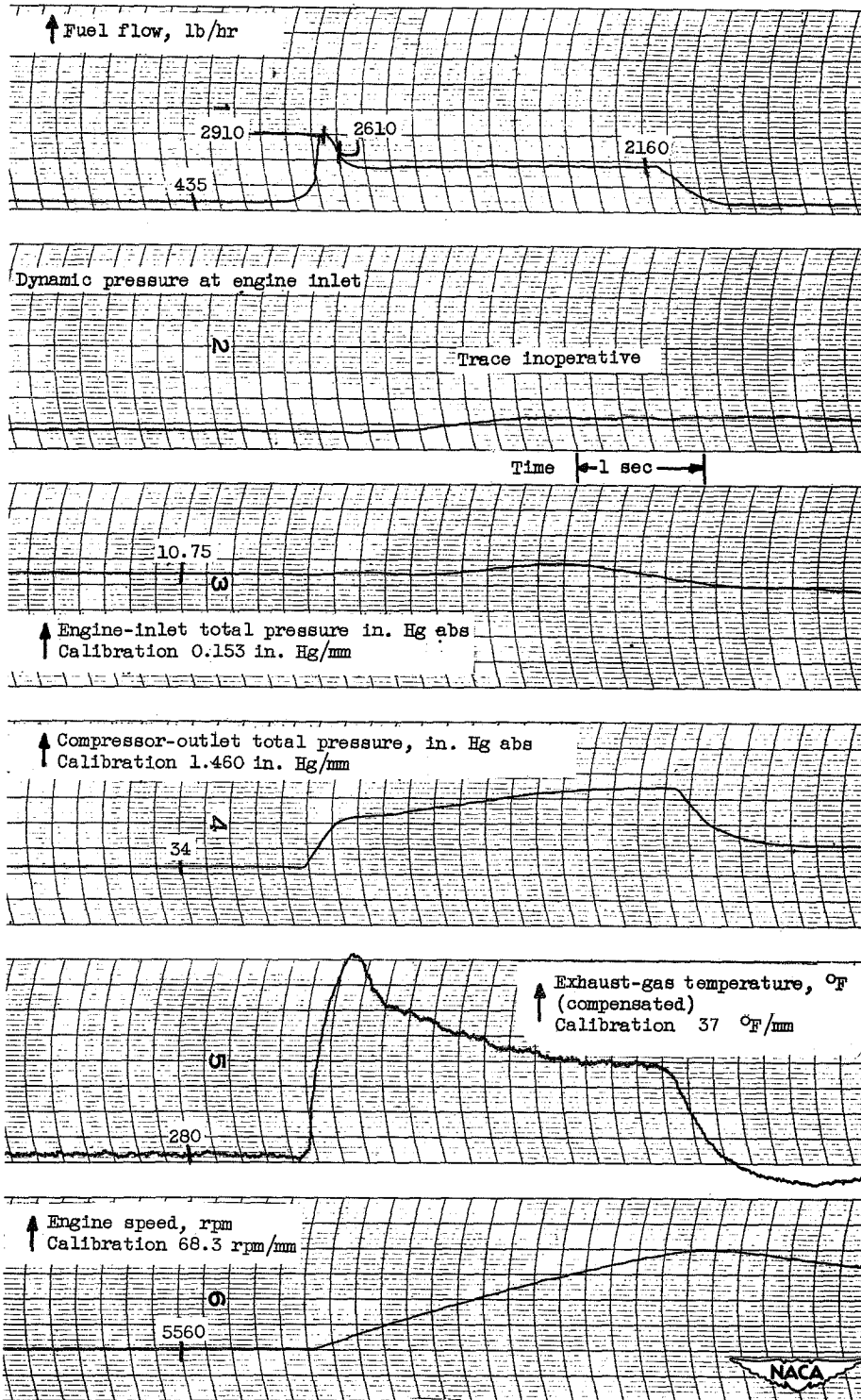


Figure 113

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 14 ° F; inlet guide vanes position, closed.

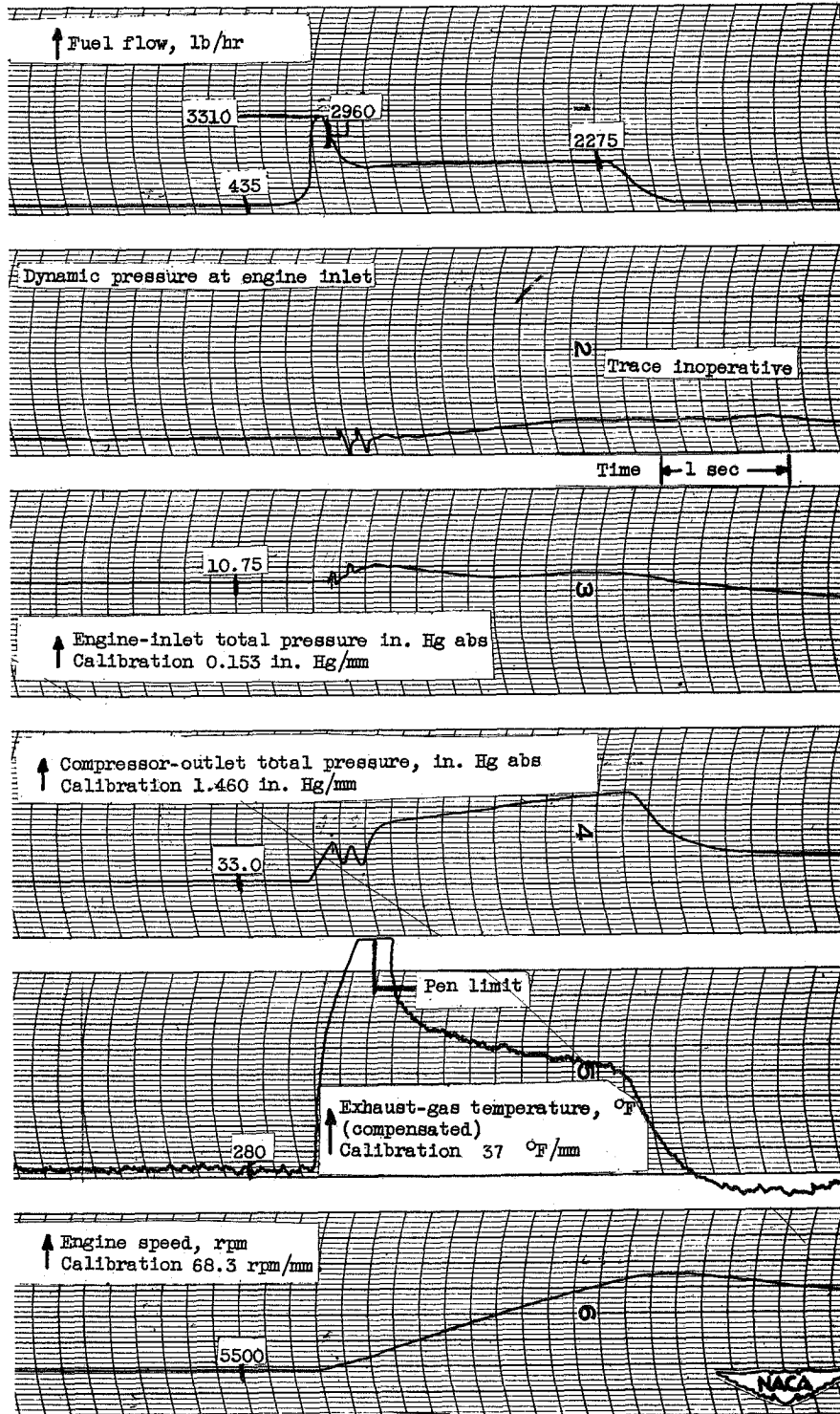


Figure 114

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 14 ° F; inlet guide vanes position, closed.

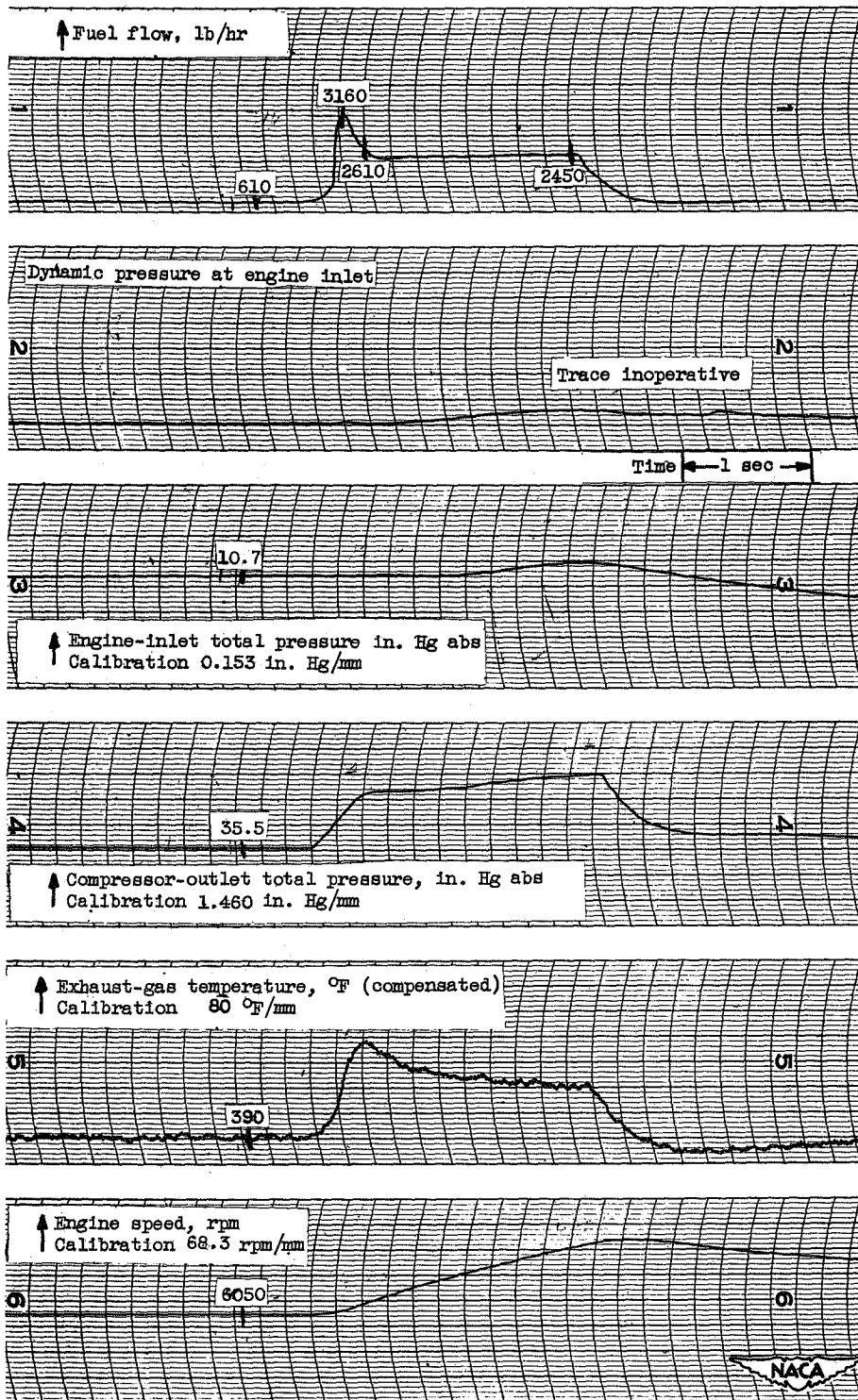


Figure 115
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; Flight Mach number, .08; engine-inlet air temperature, 11 ° F; inlet guide vanes position, closed.

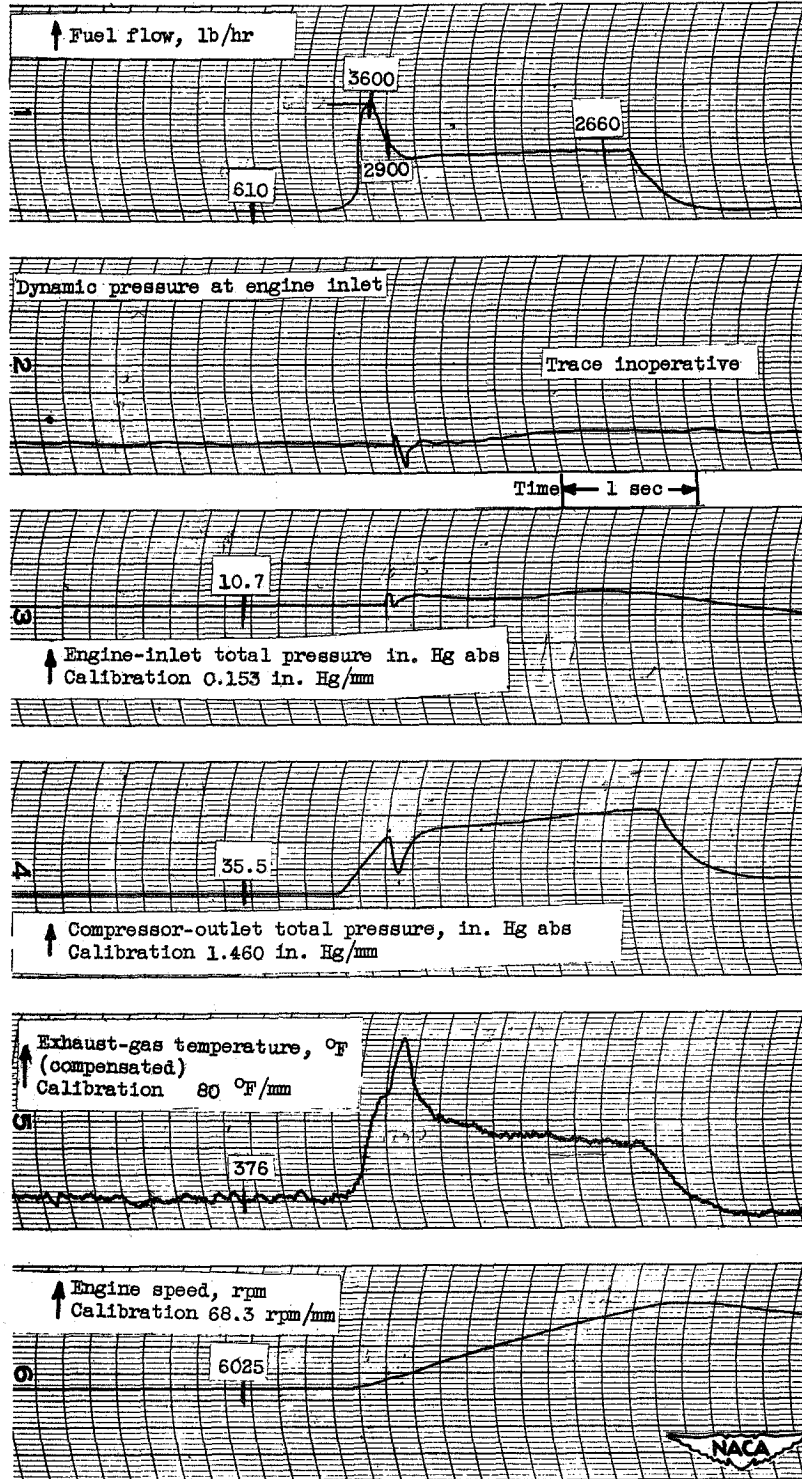


Figure 116

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 14 ° F; inlet guide vanes position, closed.

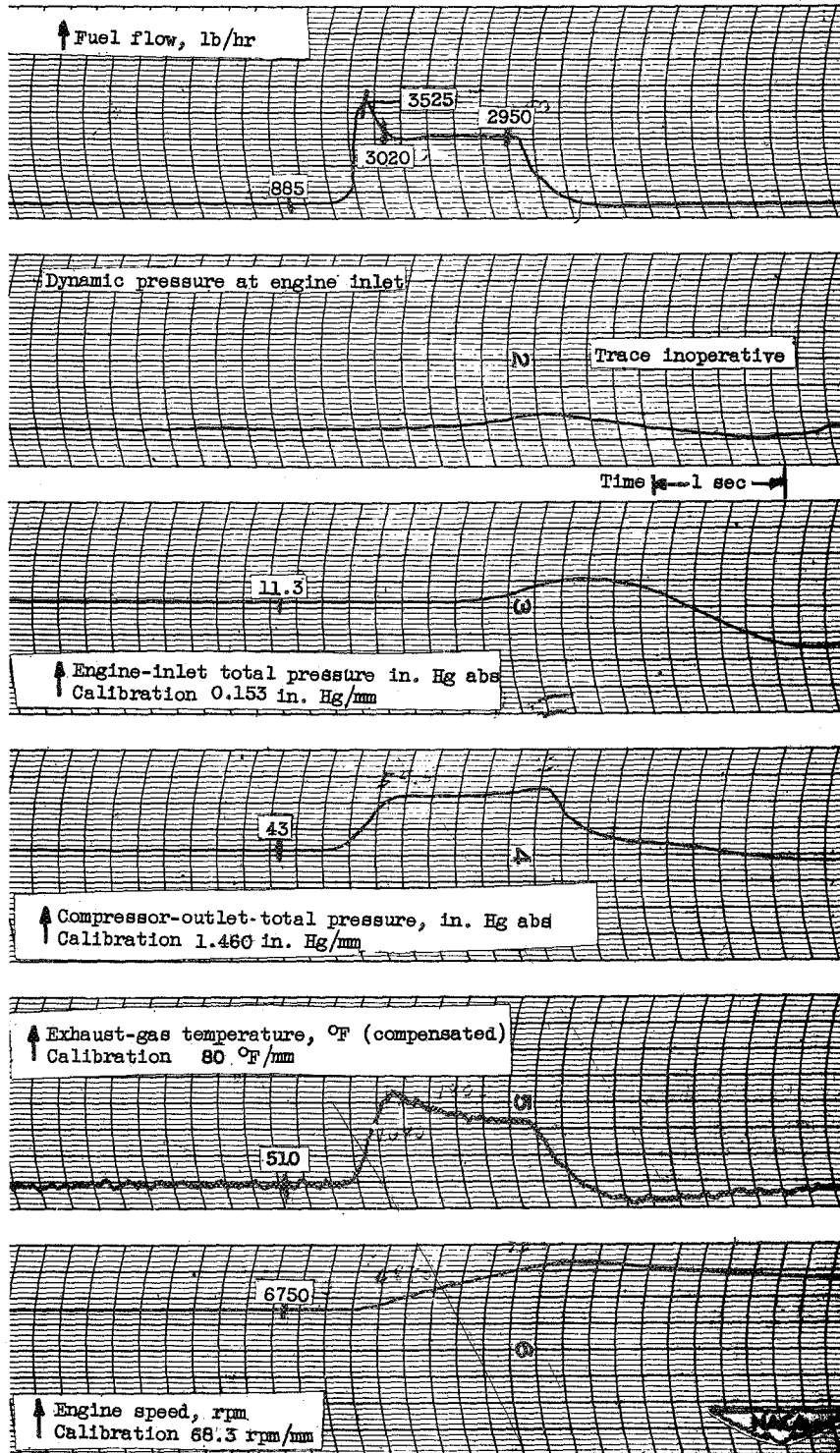


Figure 117

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine inlet air temperature, 9 °F; inlet guide vanes position, closed.

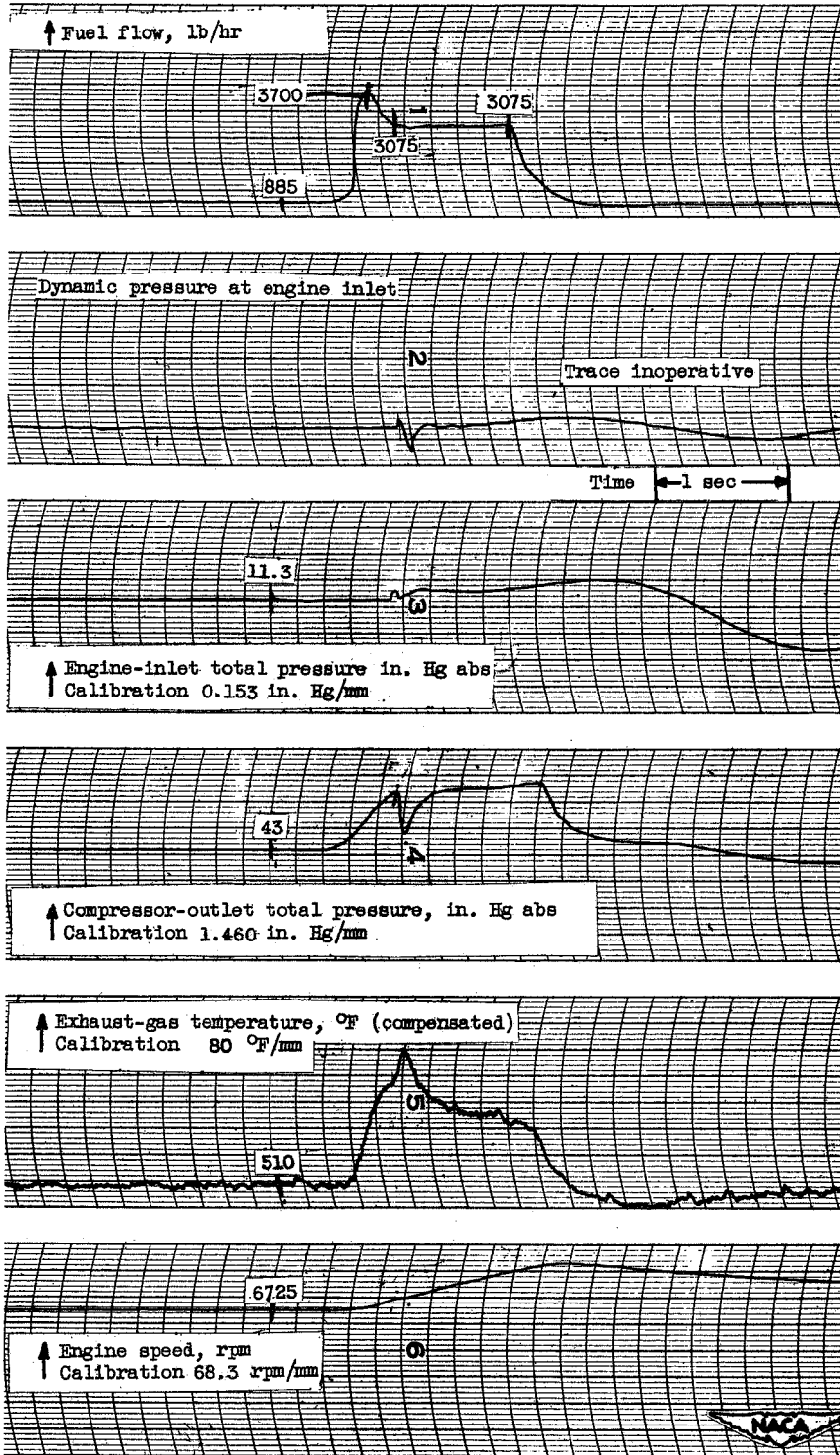


Figure 118
 Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 9 ° F; inlet guide vanes position, closed.

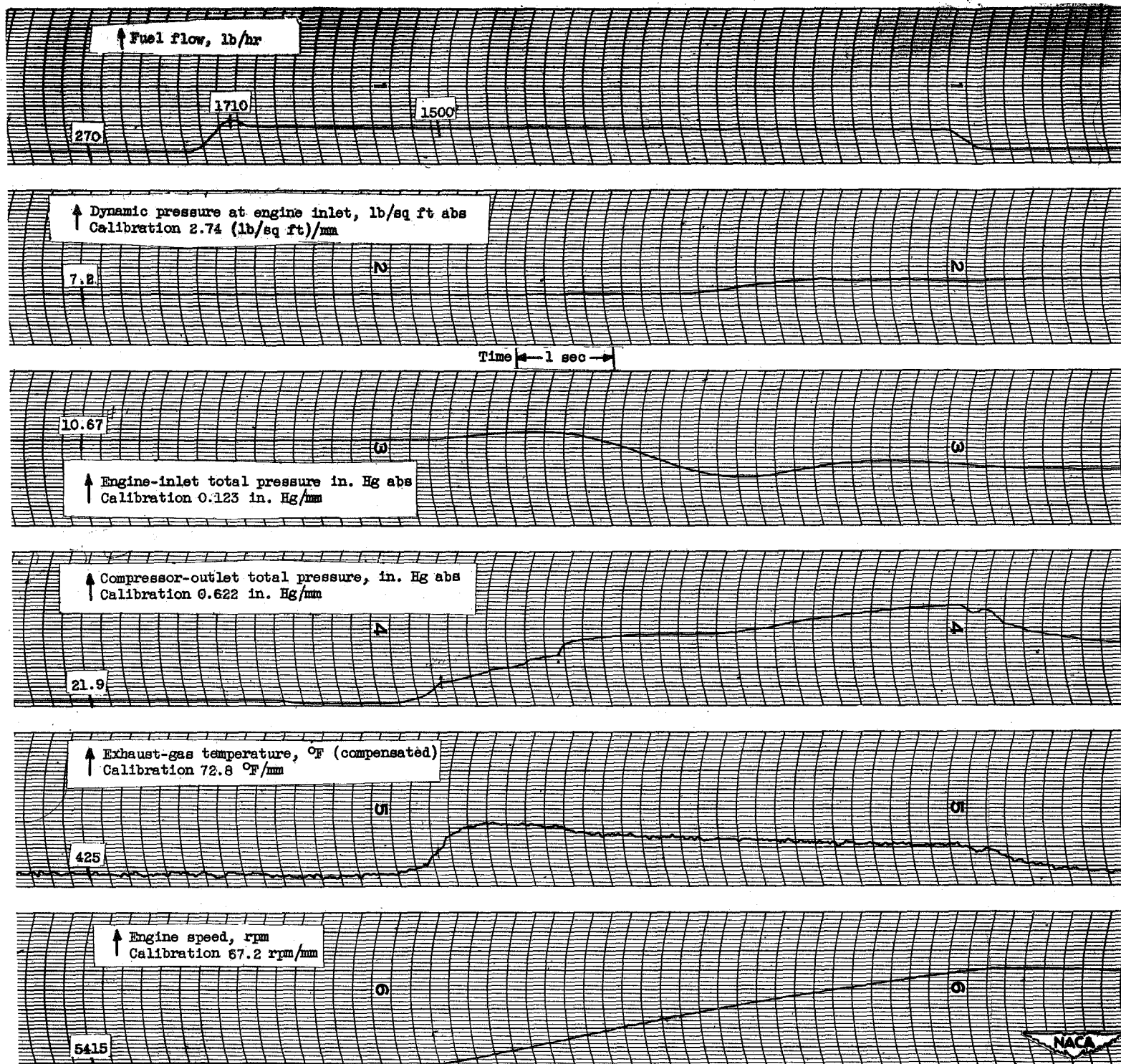


Figure 119

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 167° F; inlet guide vanes position, closed.

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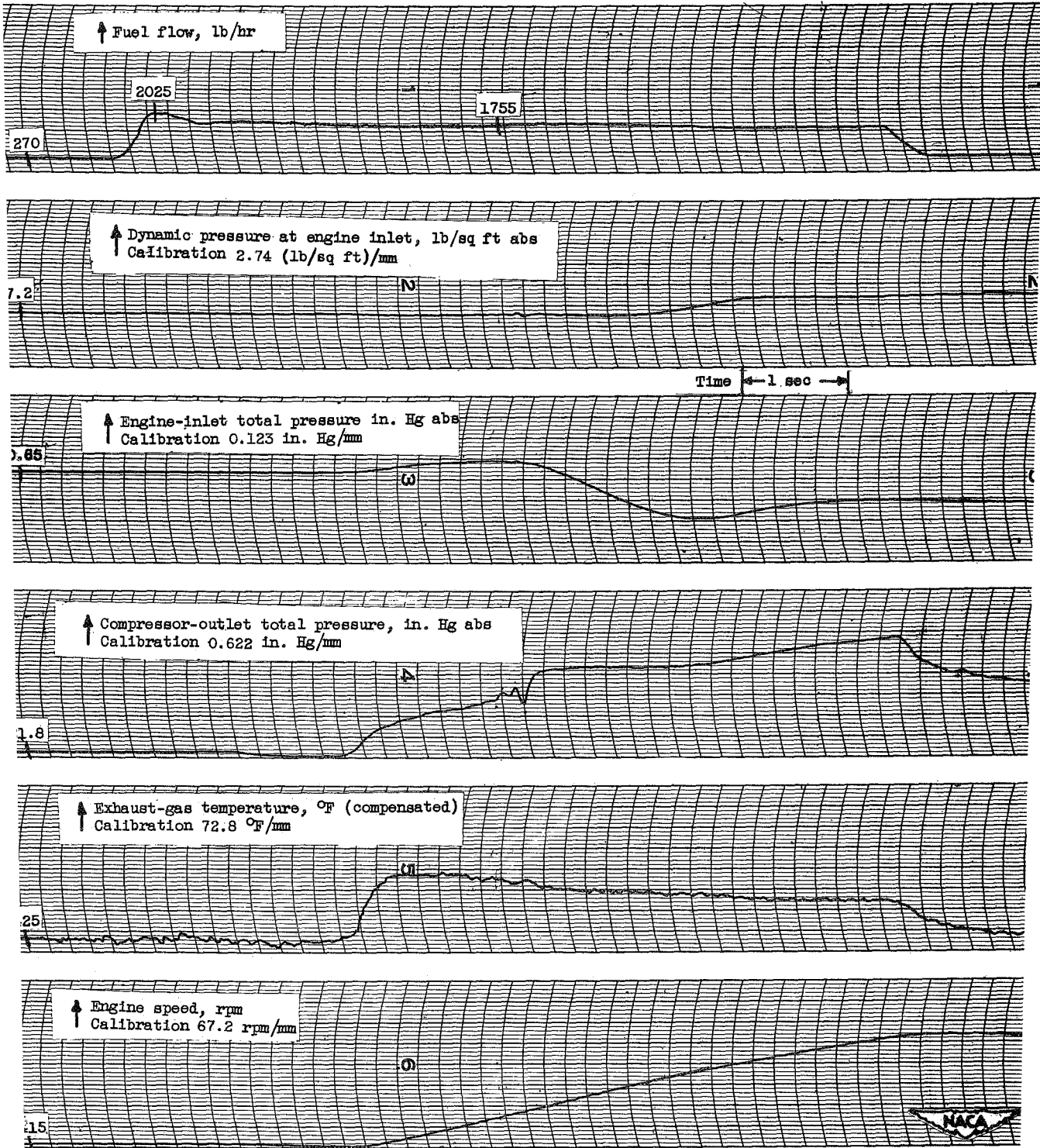


Figure 120

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 167 ° F; inlet guide vanes position, closed.

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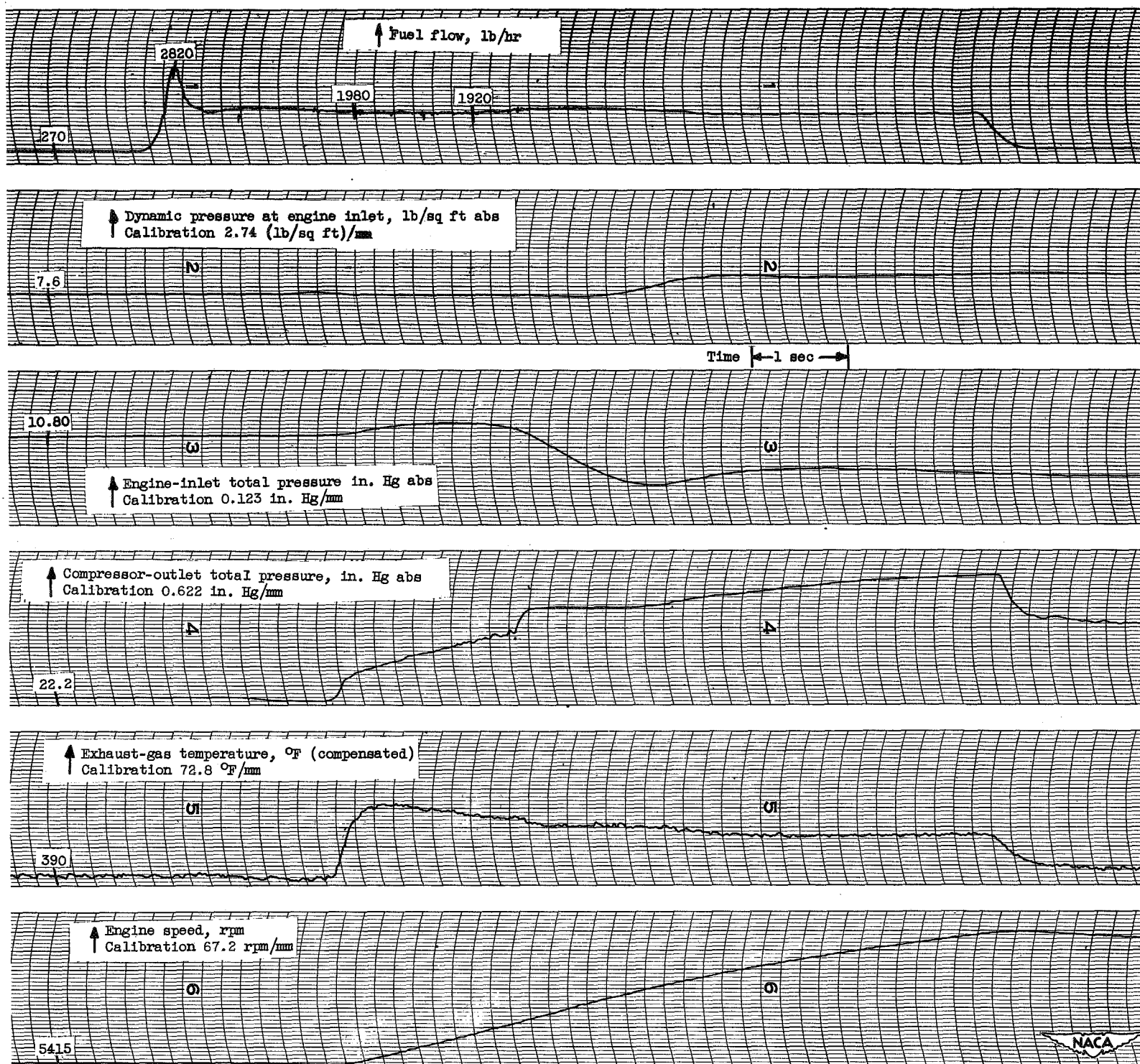


Figure 121
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 167° F; inlet guide vanes position, closed.

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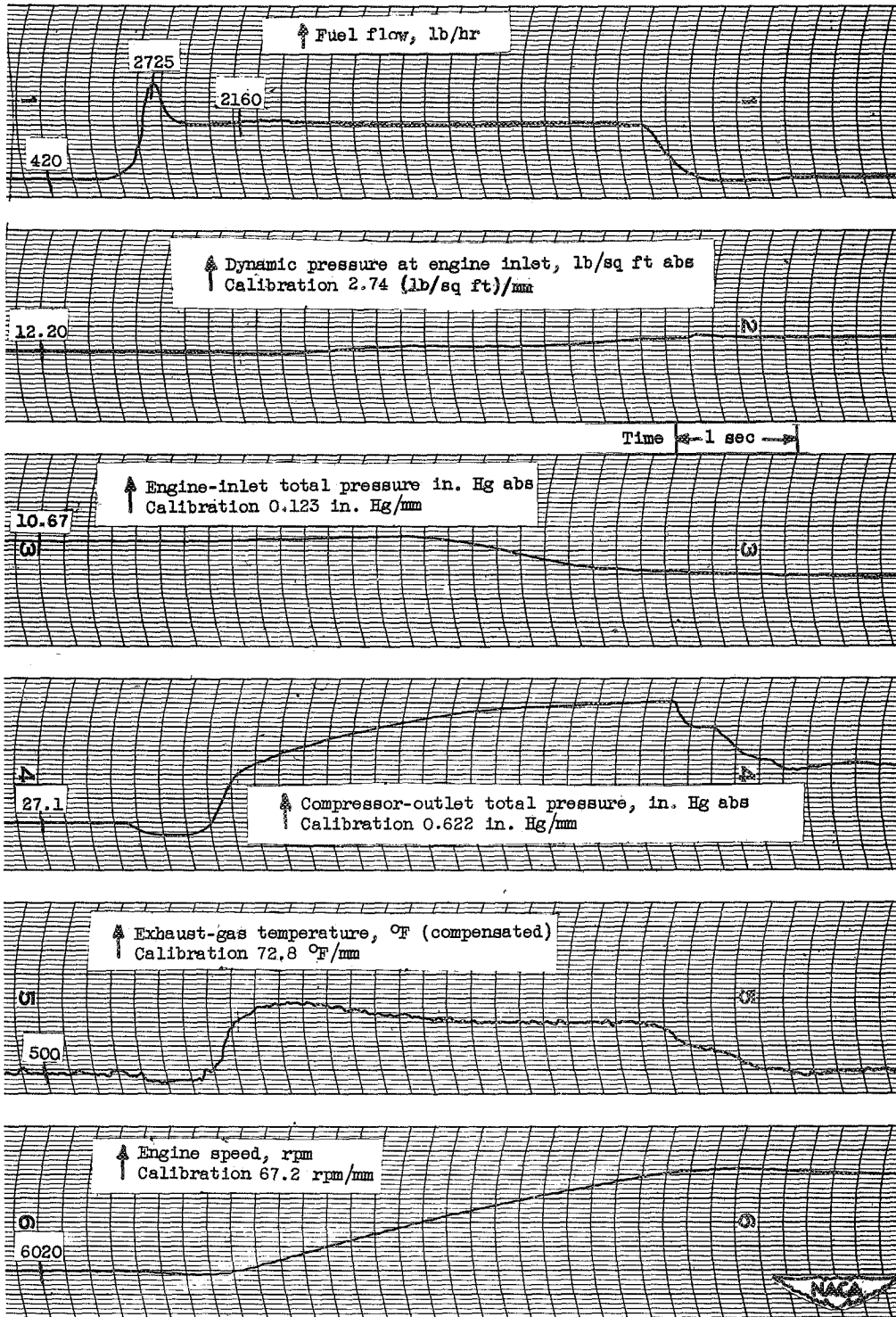


Figure 122

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 163° F; inlet guide vanes position, closed.

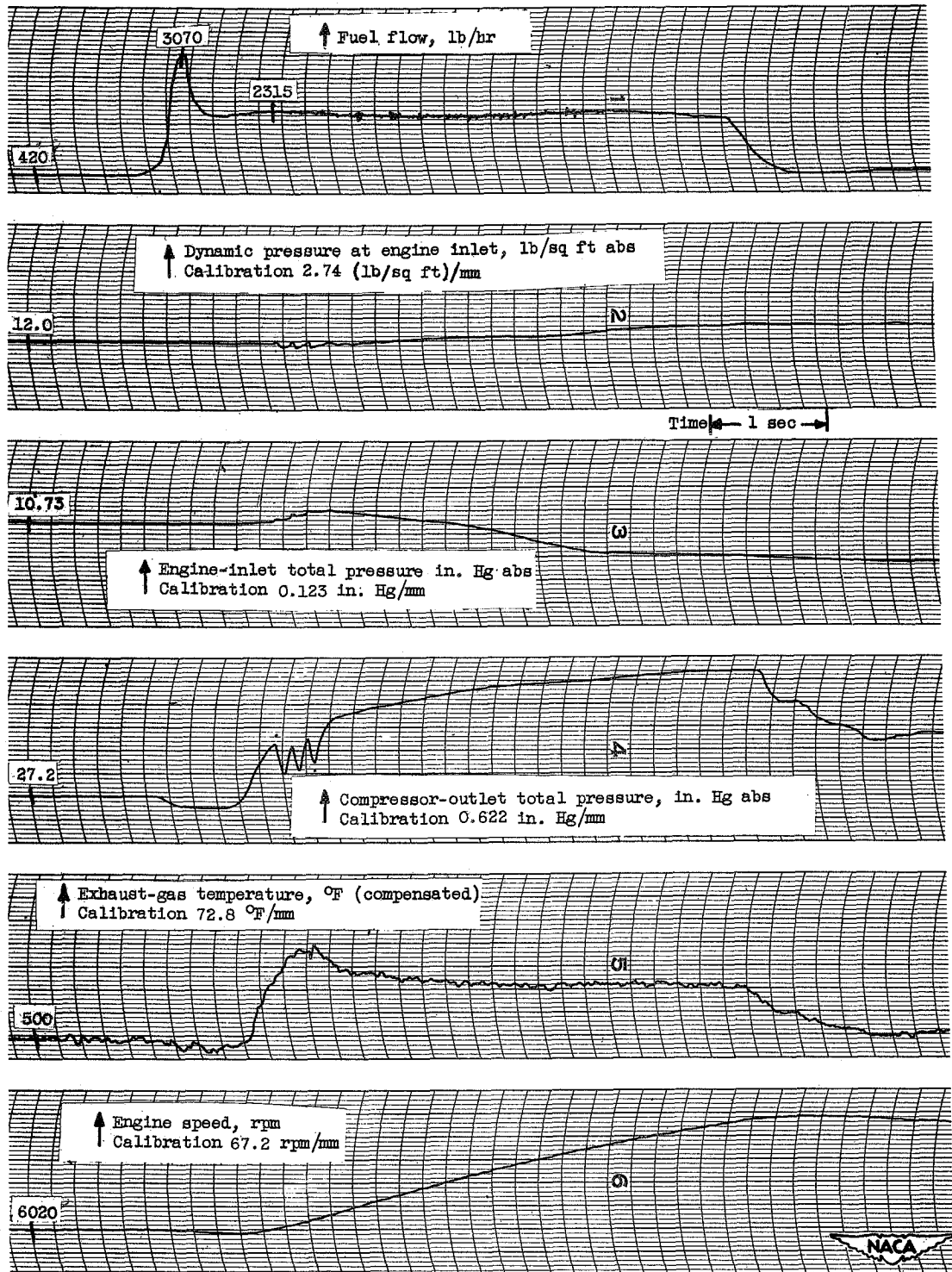


Figure 123

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 163° F; inlet guide vanes position, closed.

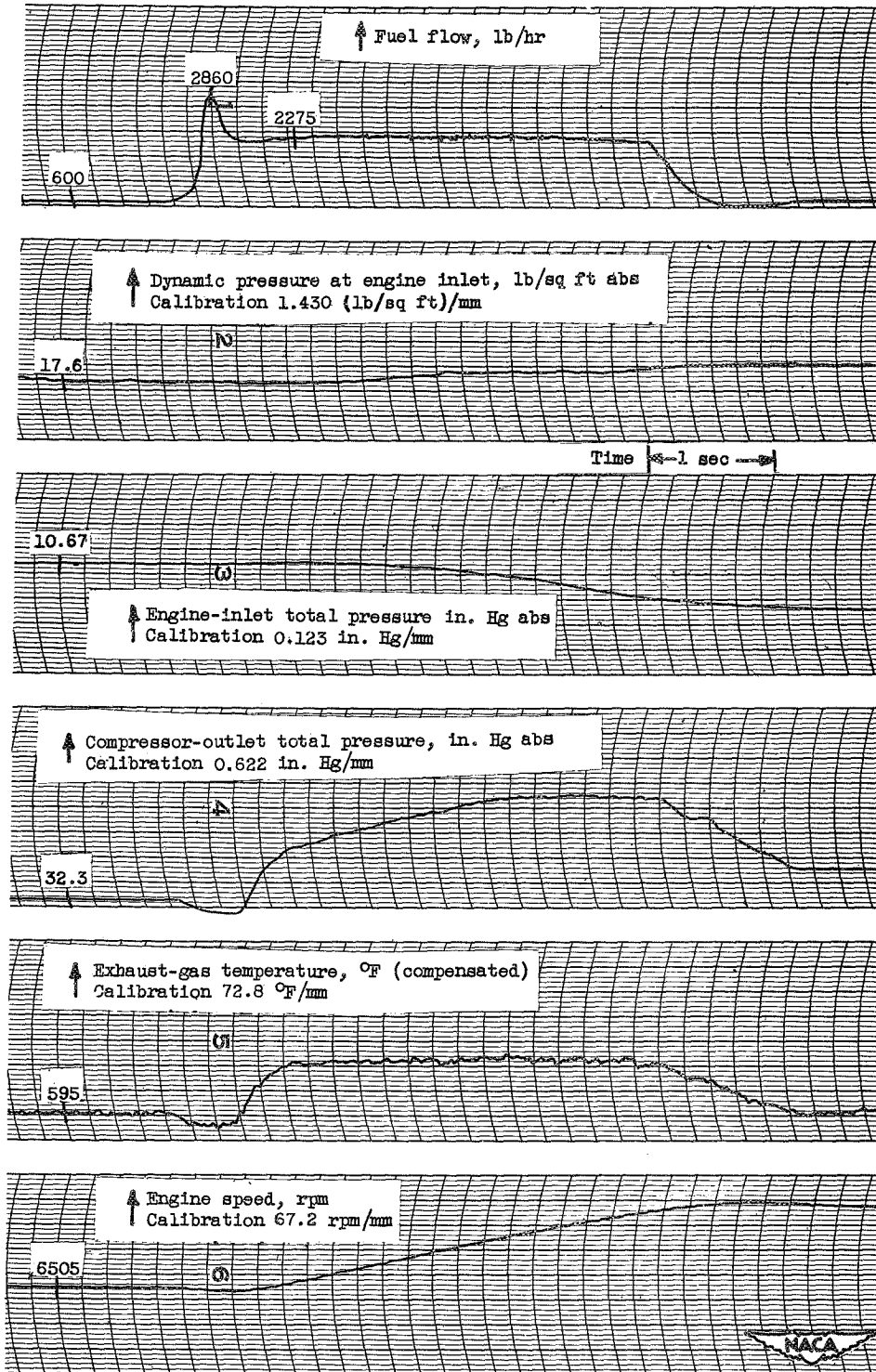


Figure 124

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 164° F; inlet guide vanes position, closed.

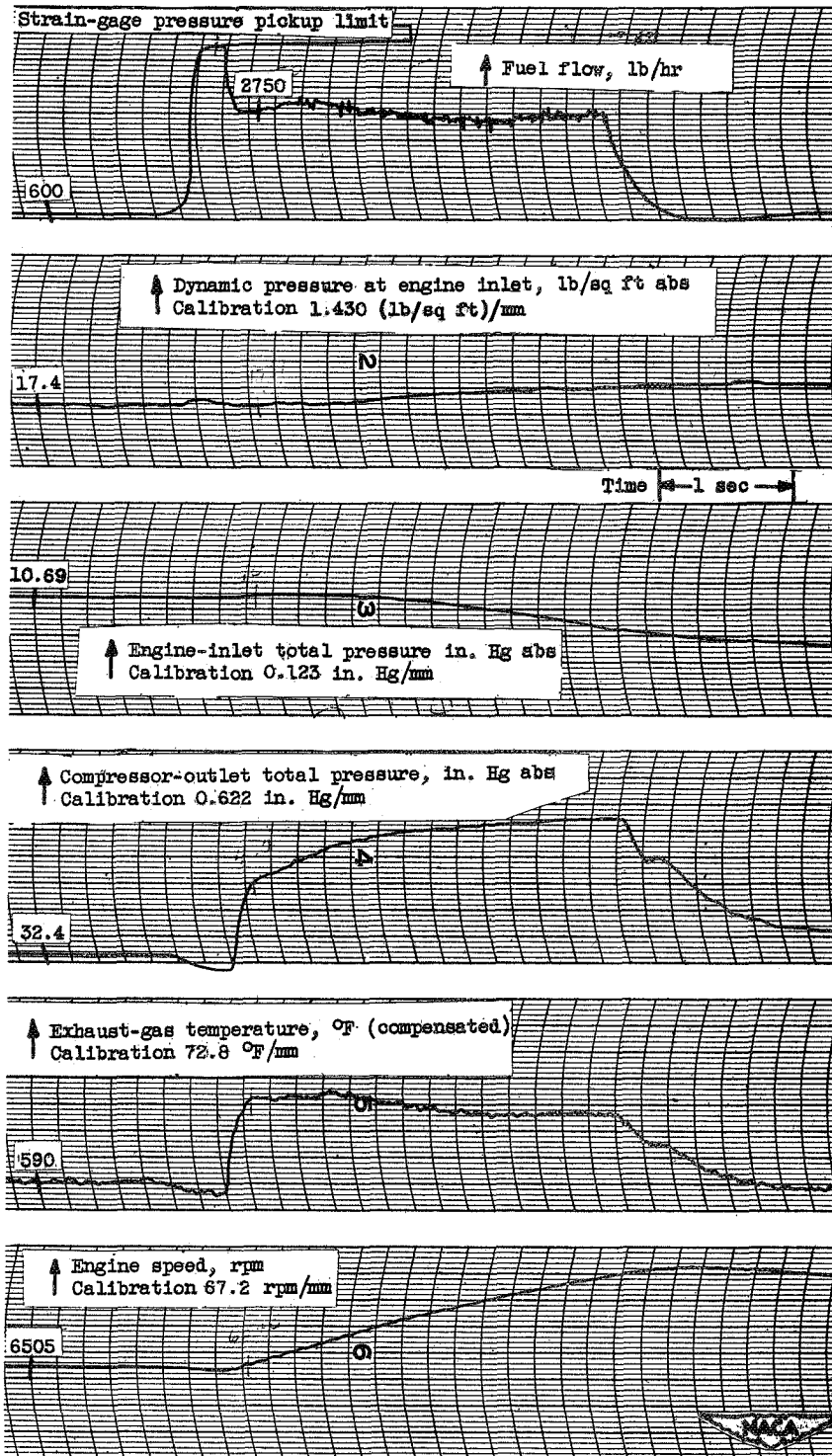


Figure 125

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 164° F; inlet guide vanes position, closed.

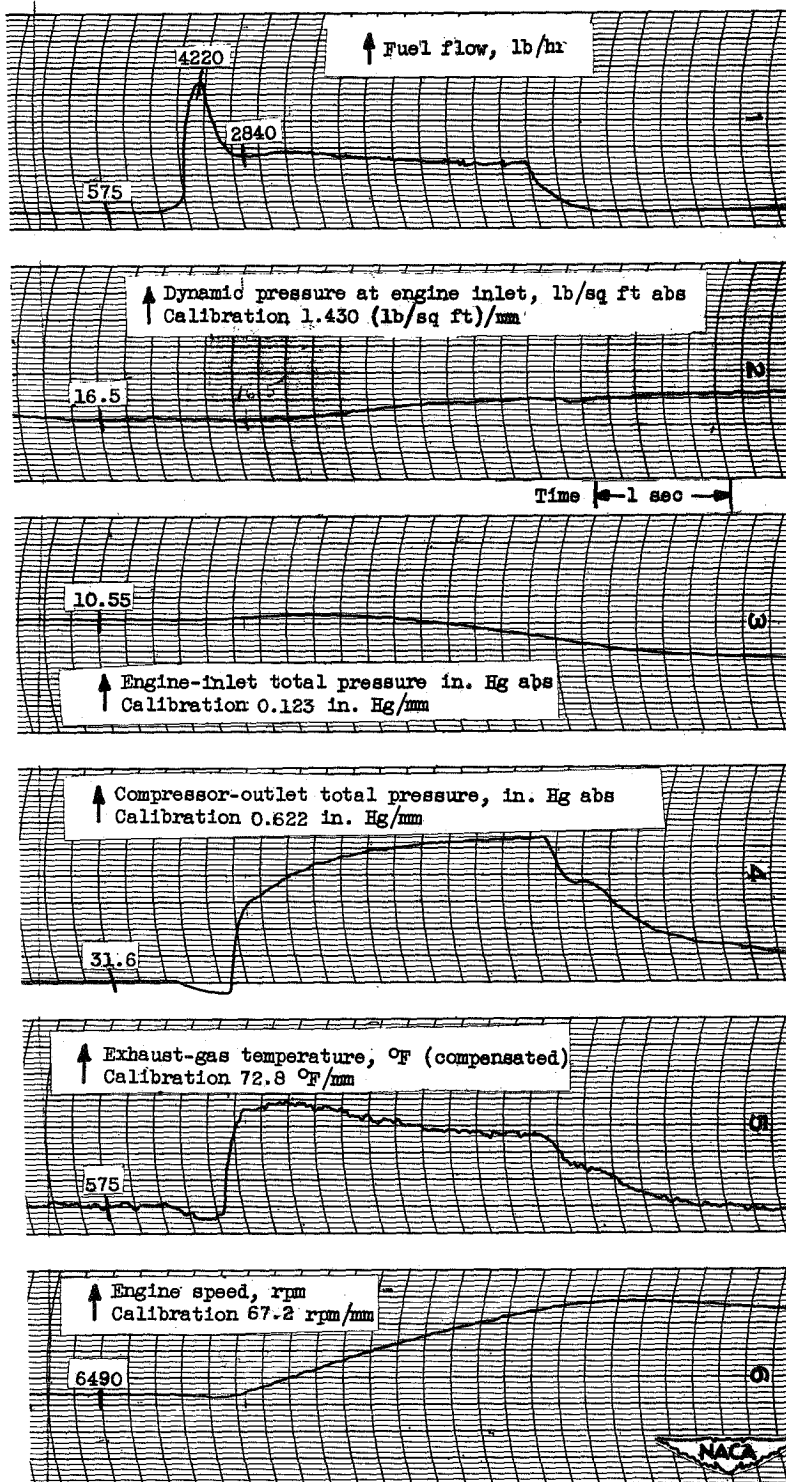


Figure 126

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 163° F; inlet guide vanes position, closed.

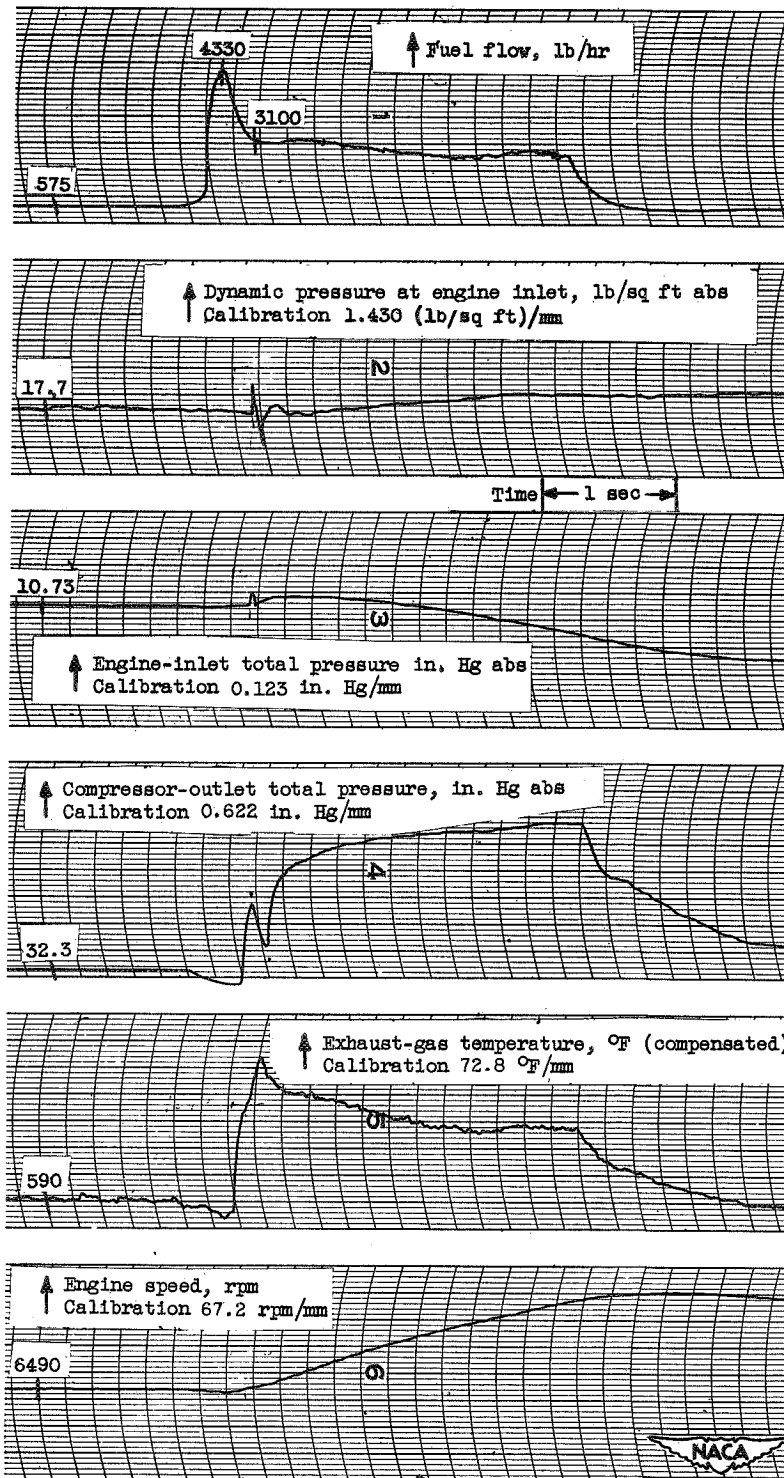


Figure 127

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 163° F; inlet guide vanes position, closed.

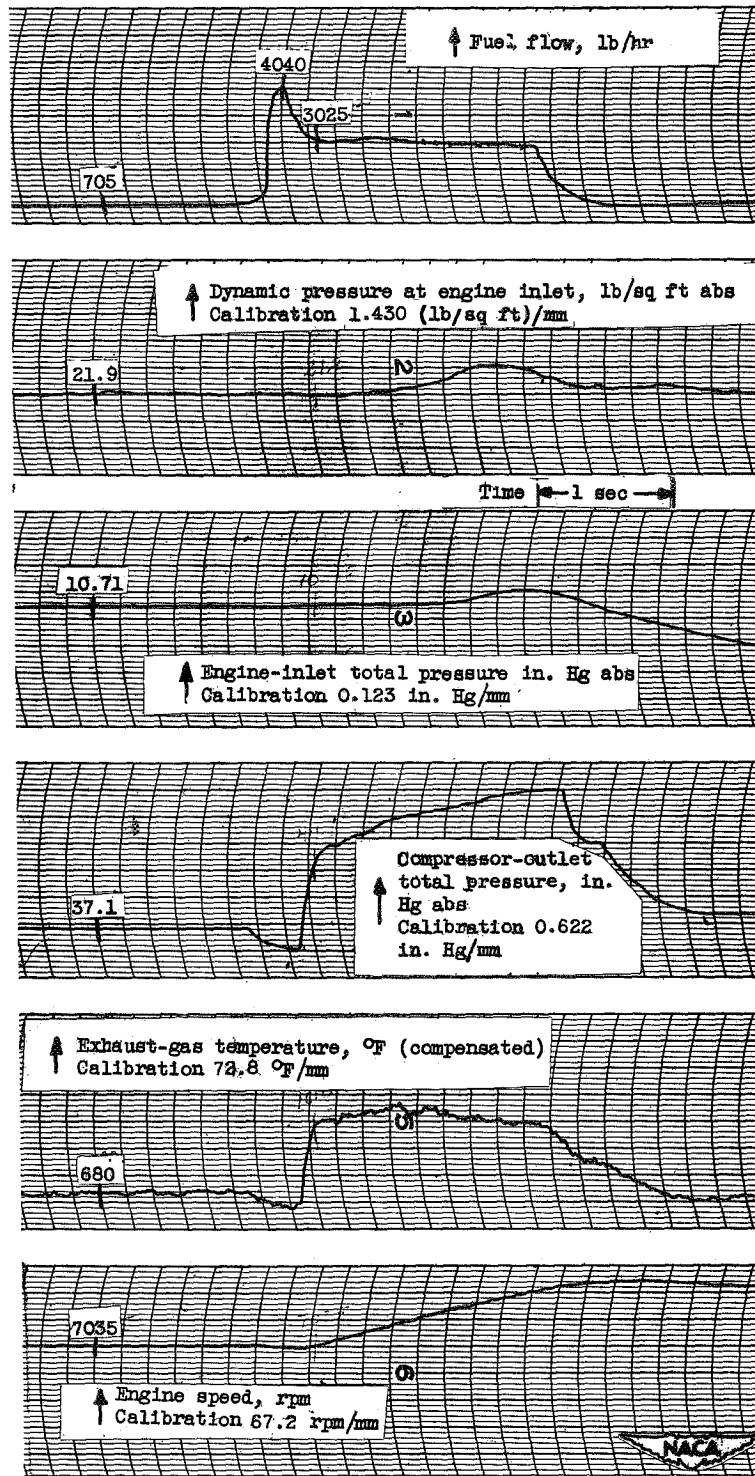


Figure 128

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 163° F; inlet guide vanes position, closed.

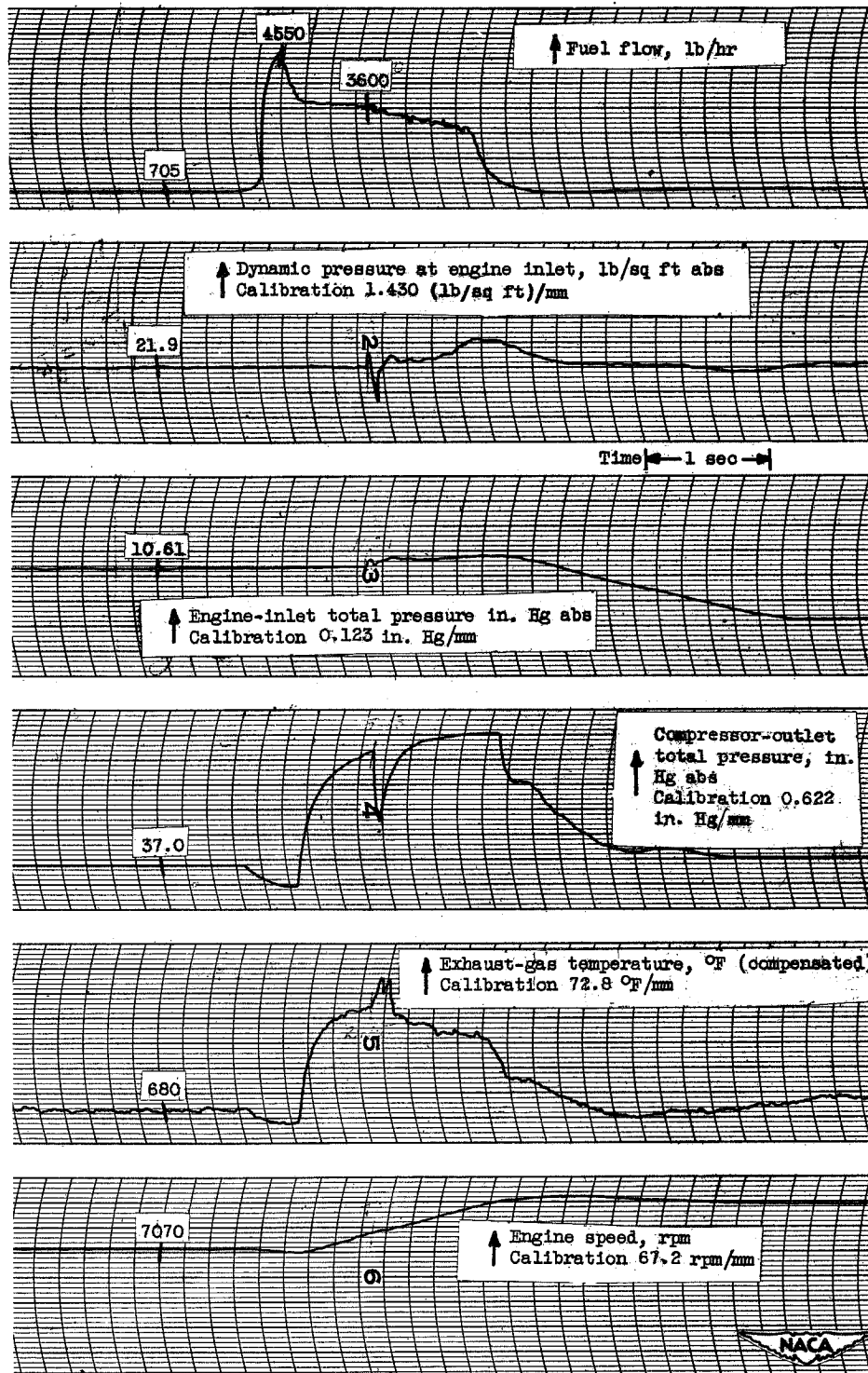


Figure 129

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 0.8; engine-inlet air temperature, 163° F; inlet guide vanes position, closed.

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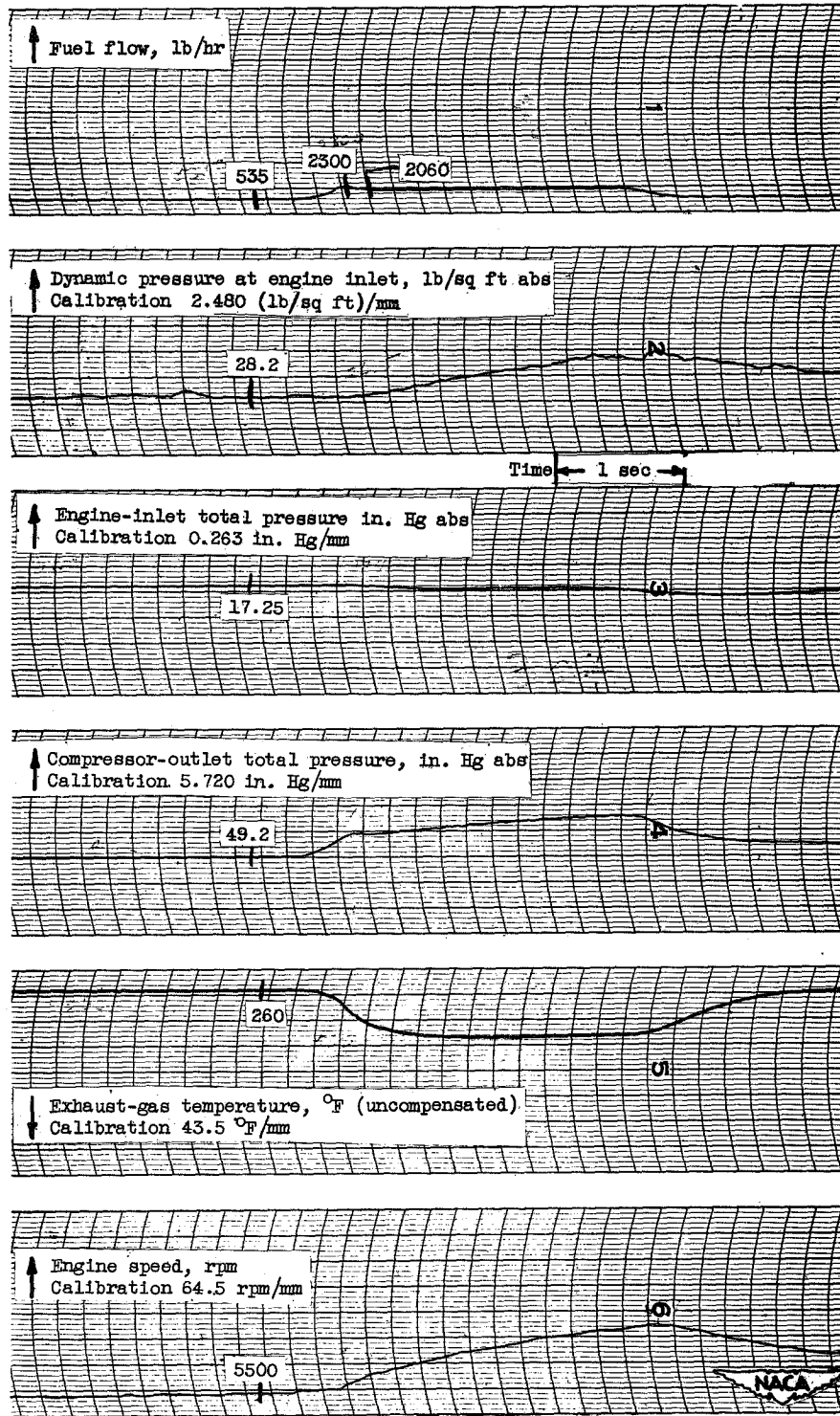


Figure 130

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 32° F; inlet guide vanes position, open.

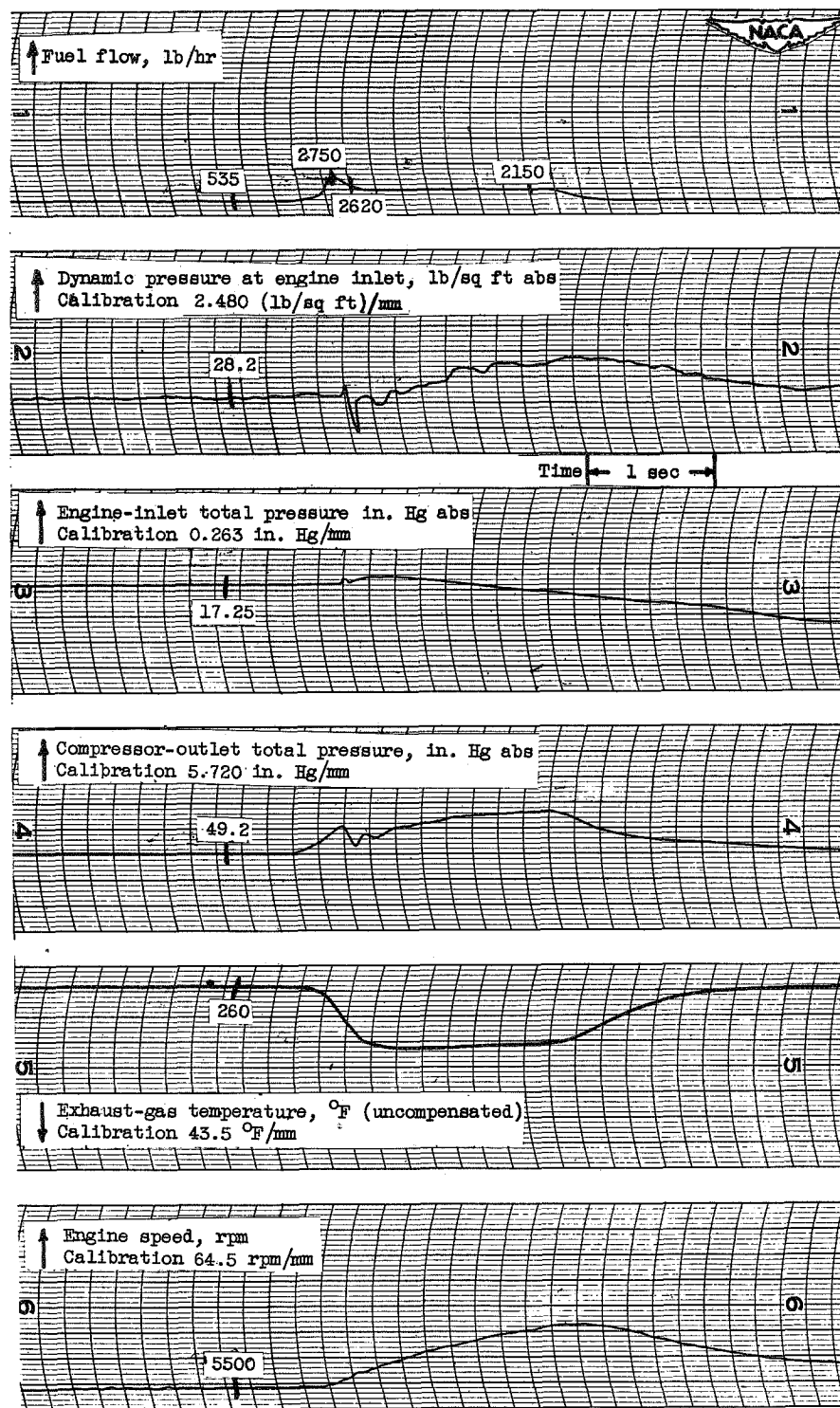


Figure 131

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 32° F; inlet guide vanes position, open.

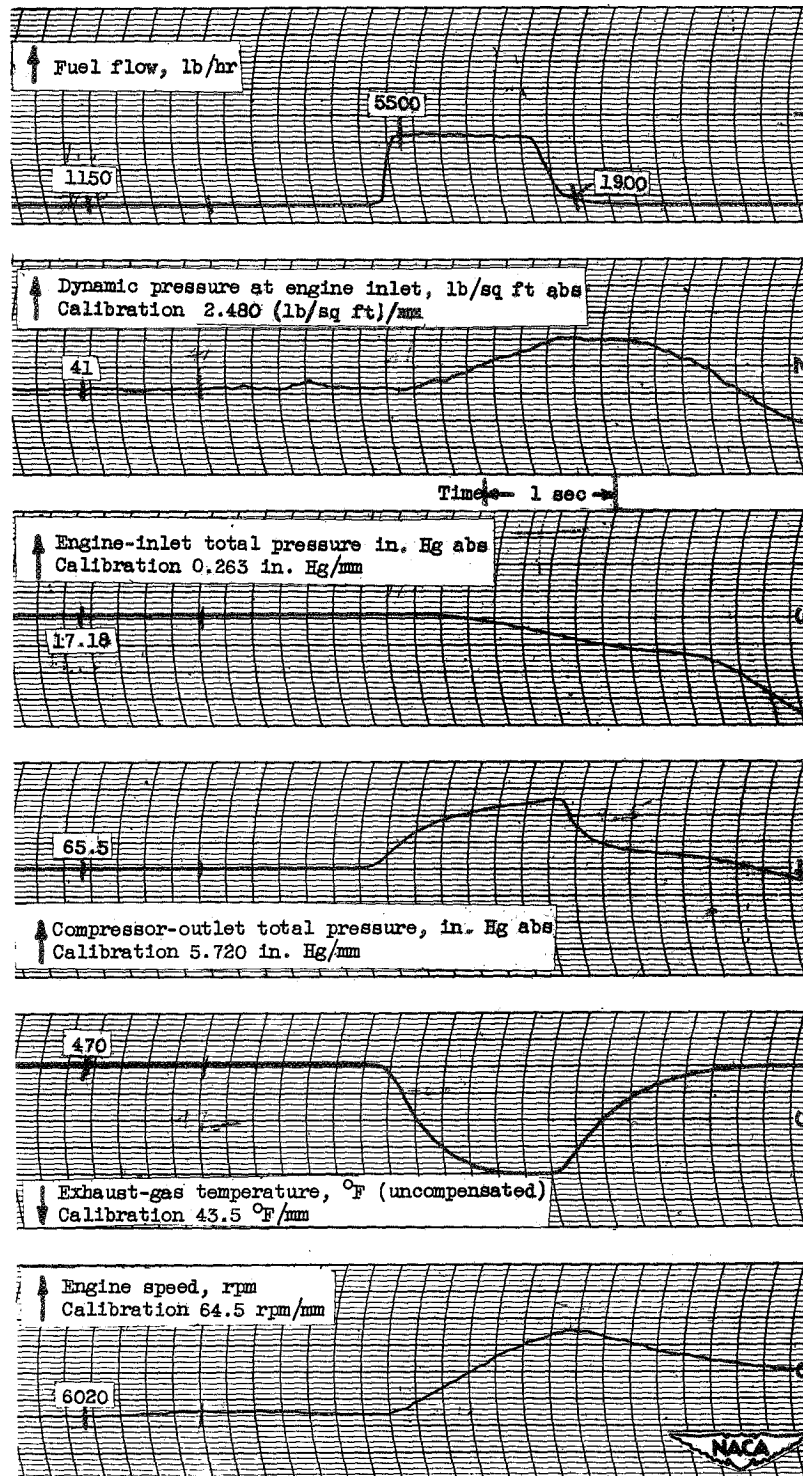


Figure 132

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 34° F; inlet guide vanes position, open.

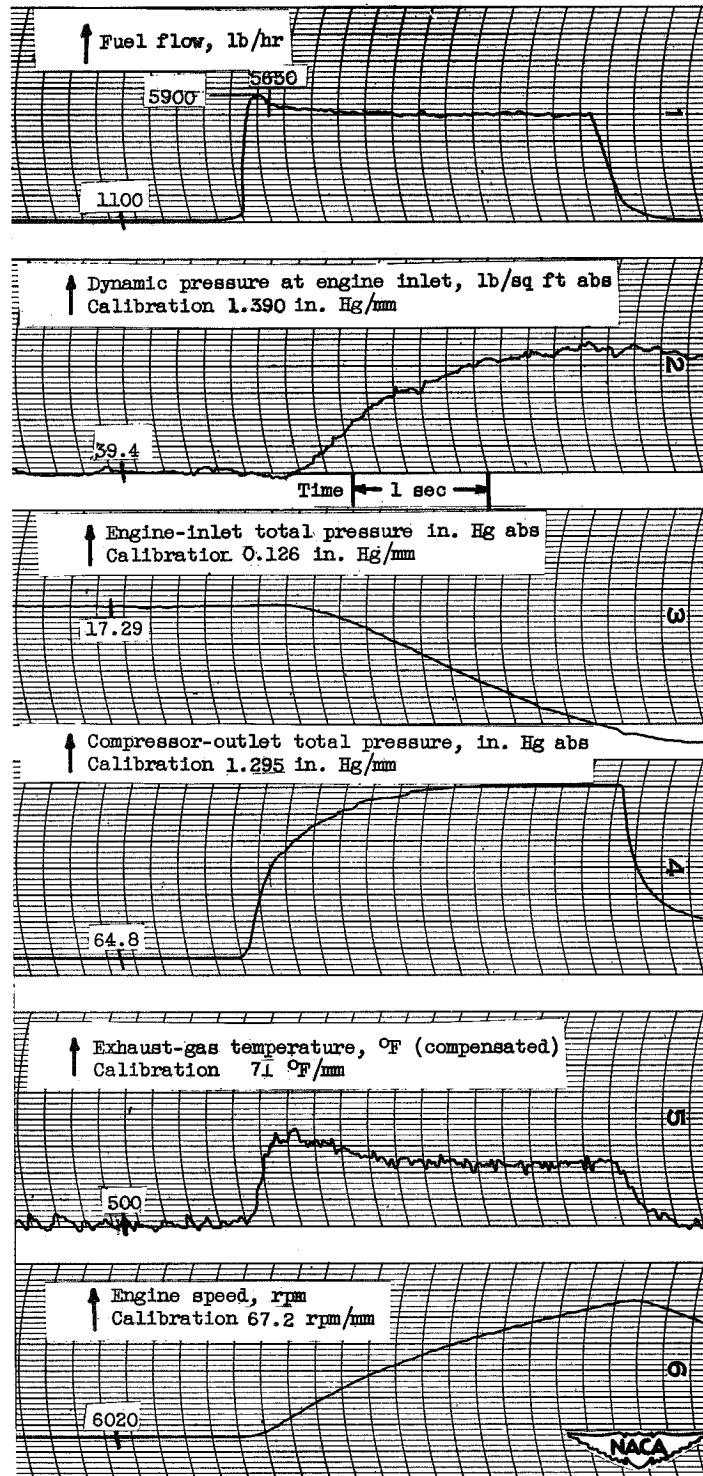


Figure 133

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 42° F; inlet guide vanes position, open.

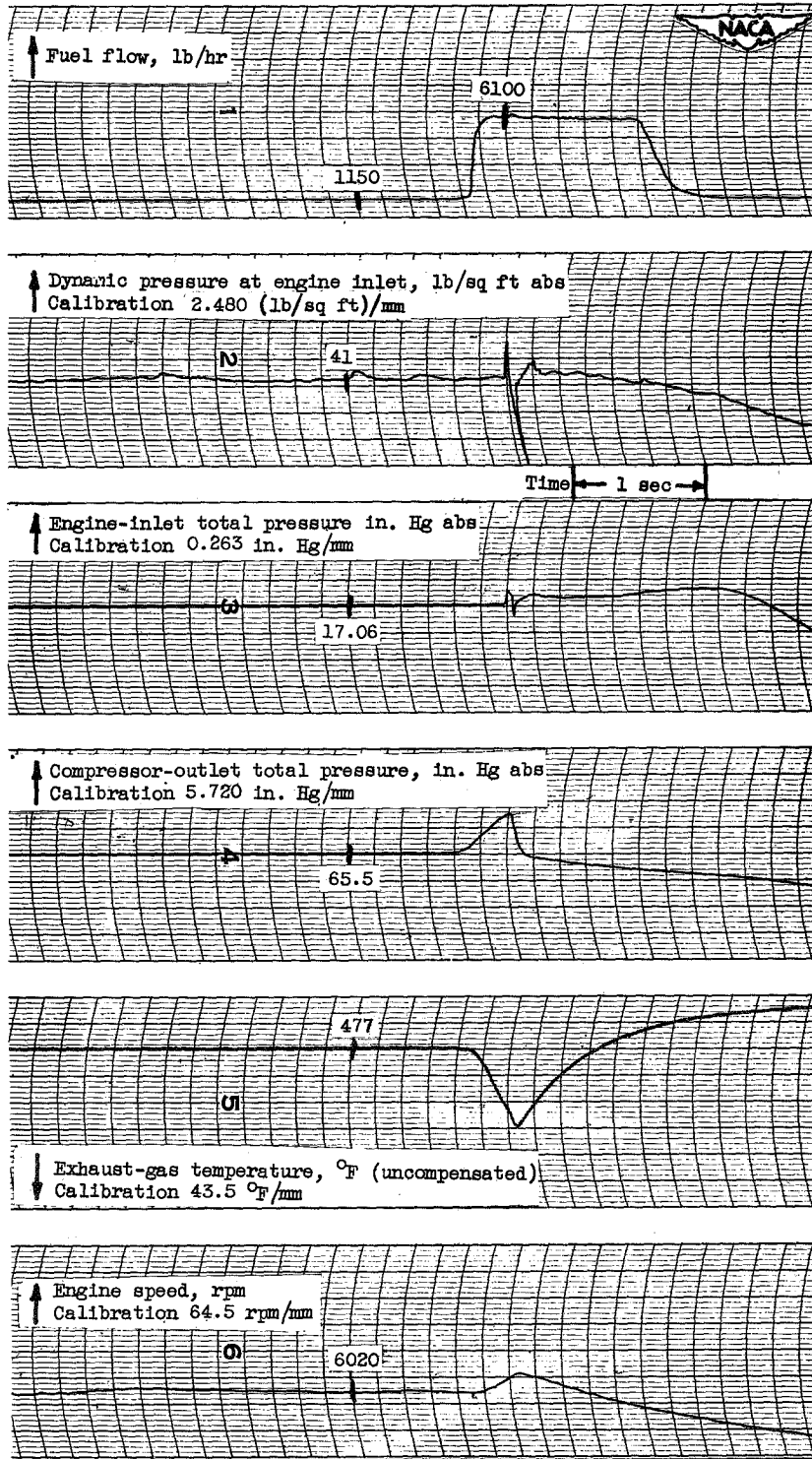


Figure 134
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 34° F; inlet guide vanes position, open.

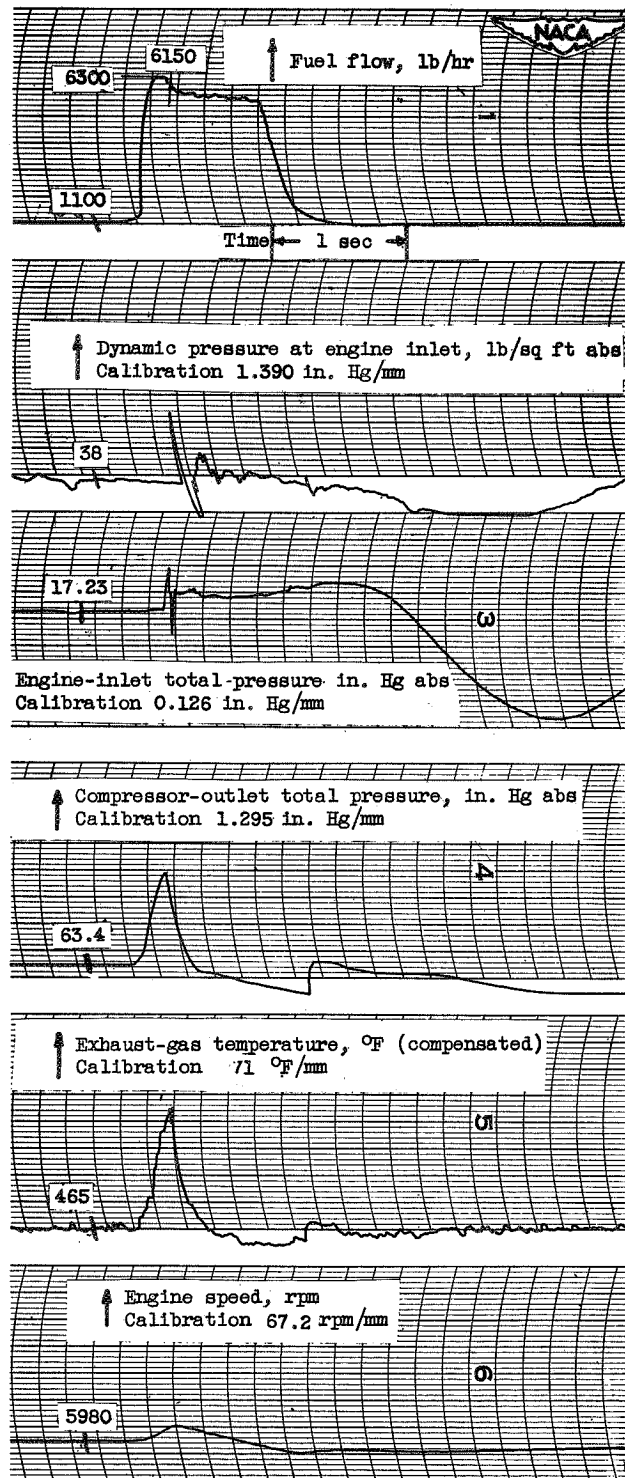


Figure 135

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 42 ° F; inlet guide vanes position, open.

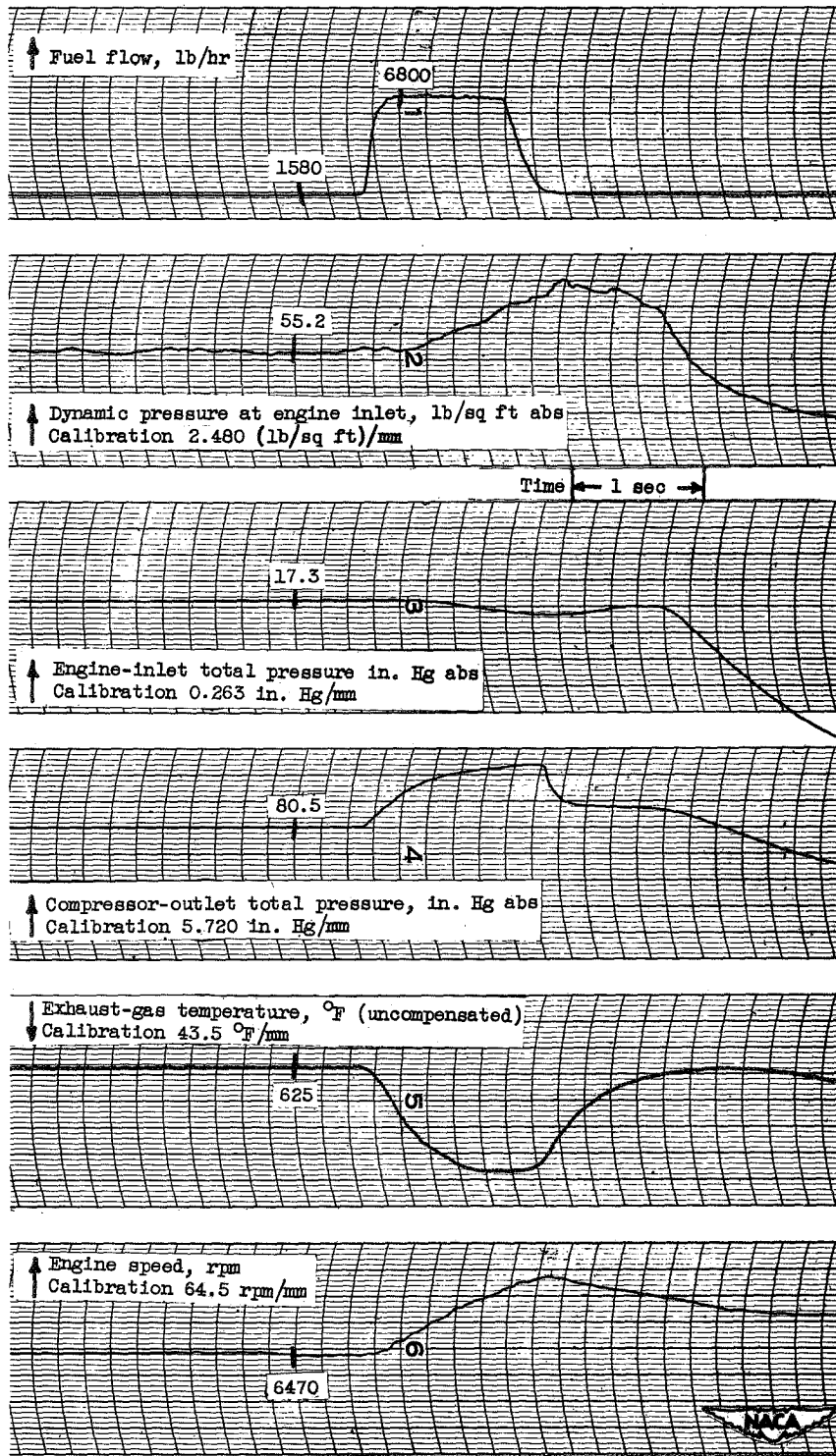


Figure 136

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 35° F; inlet guide vanes position, open.

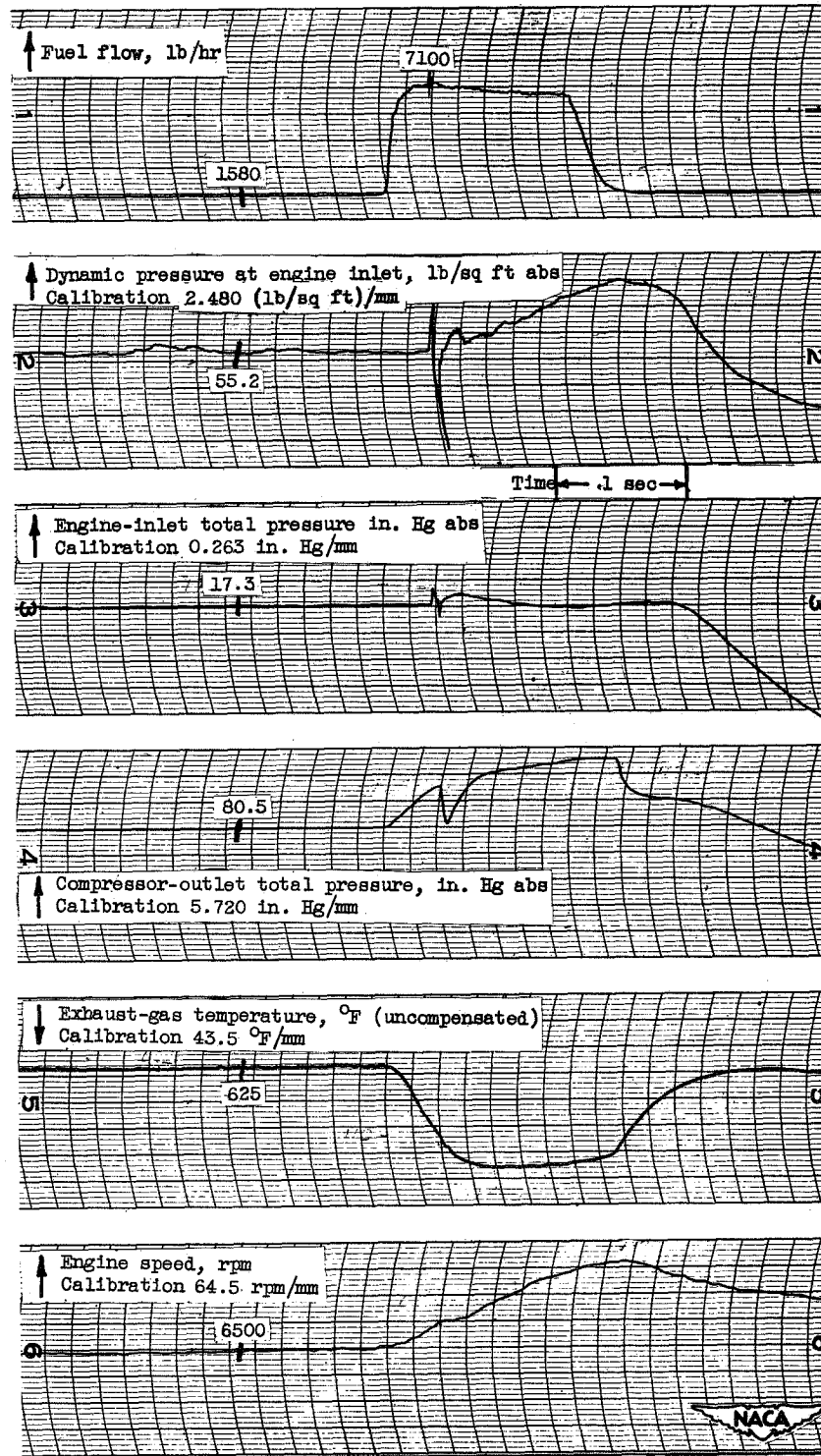


Figure 137

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 35° F; inlet guide vanes position, open.

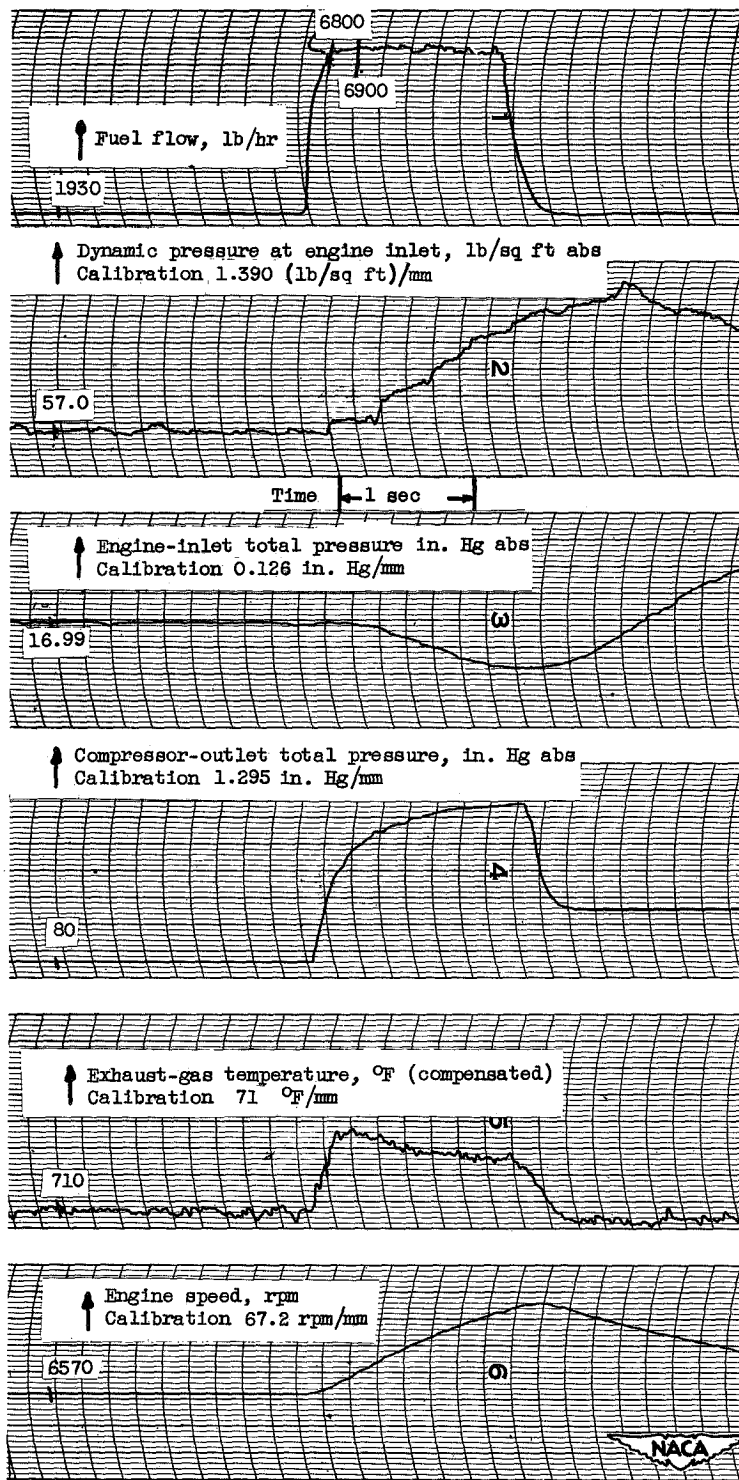


Figure 158

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 42° F; inlet guide vanes position, open.

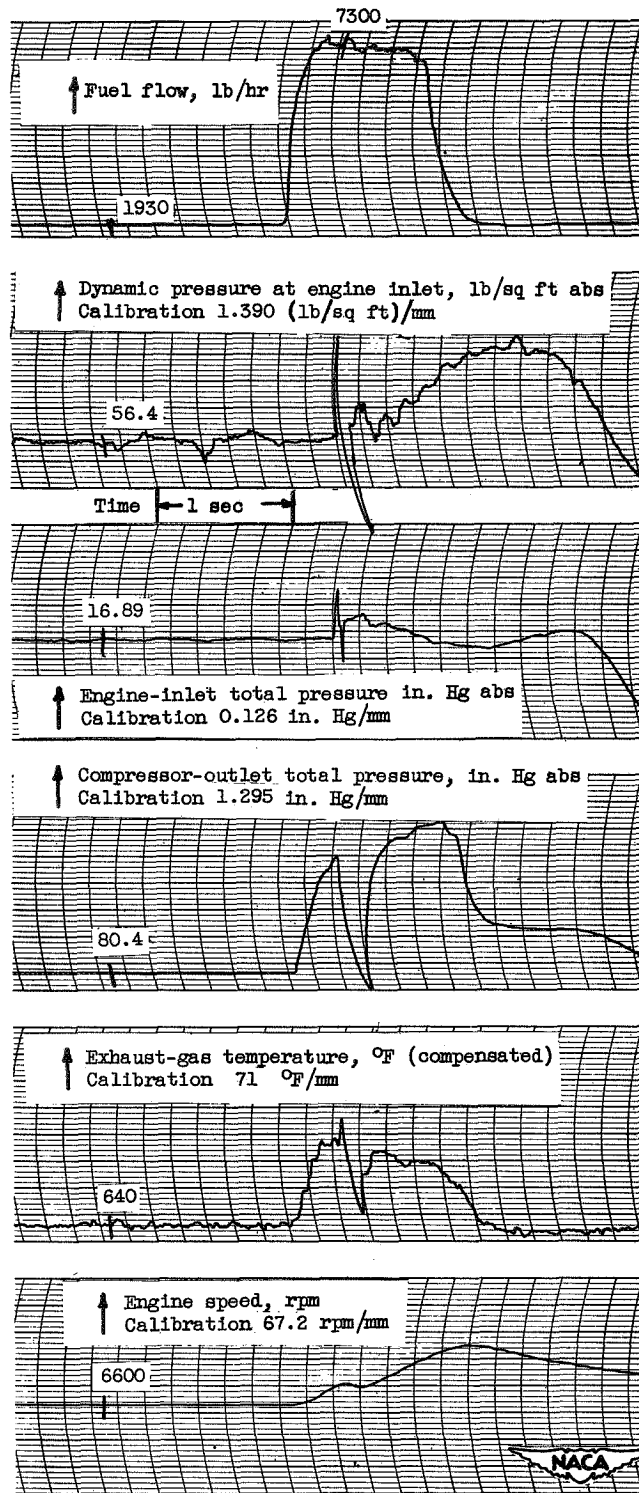


Figure 139

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 42° F; inlet guide vanes position, open.

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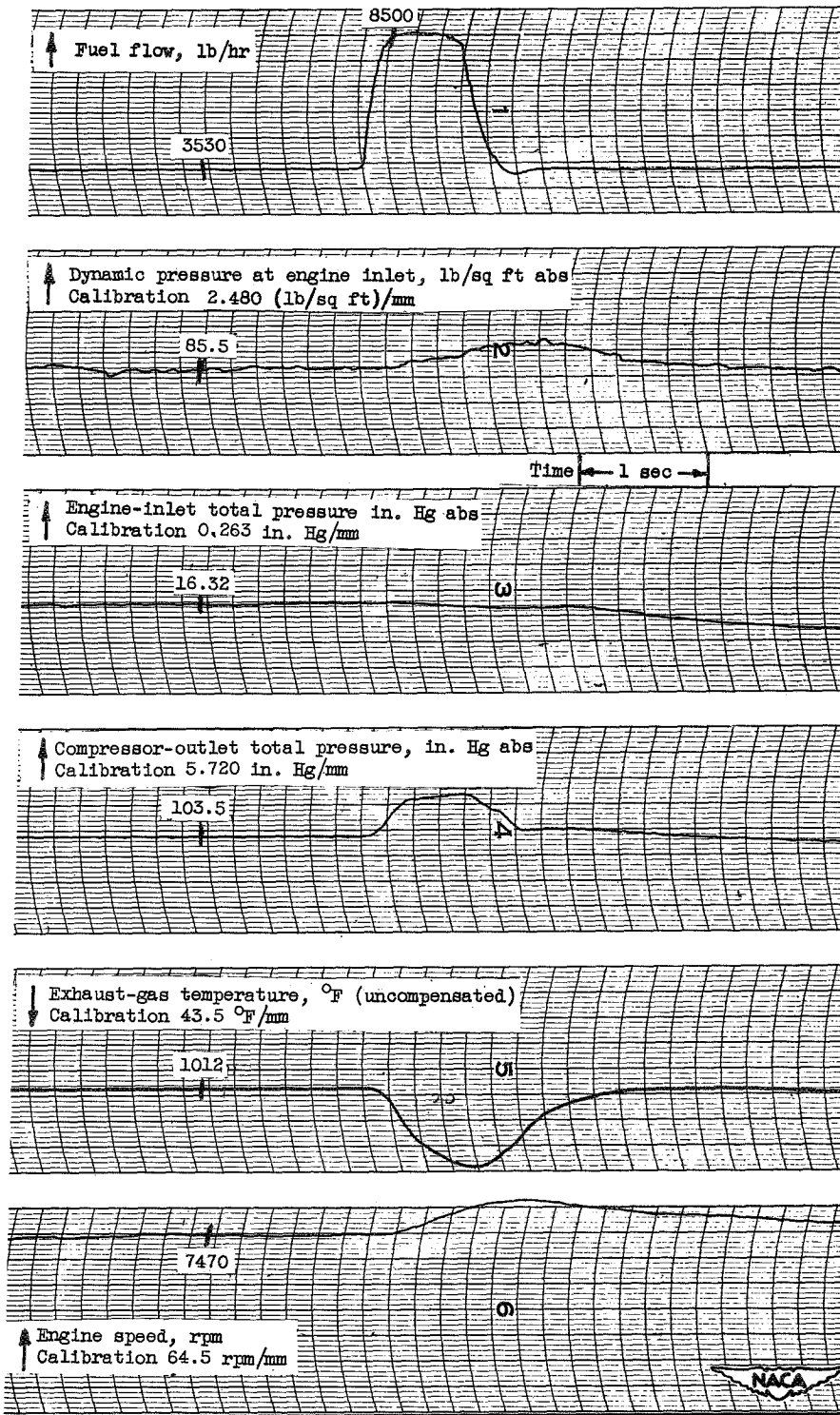


Figure 140

Oscillograph traces showing variations of different engine parameters during a step change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 35° F; inlet guide vanes position, open.

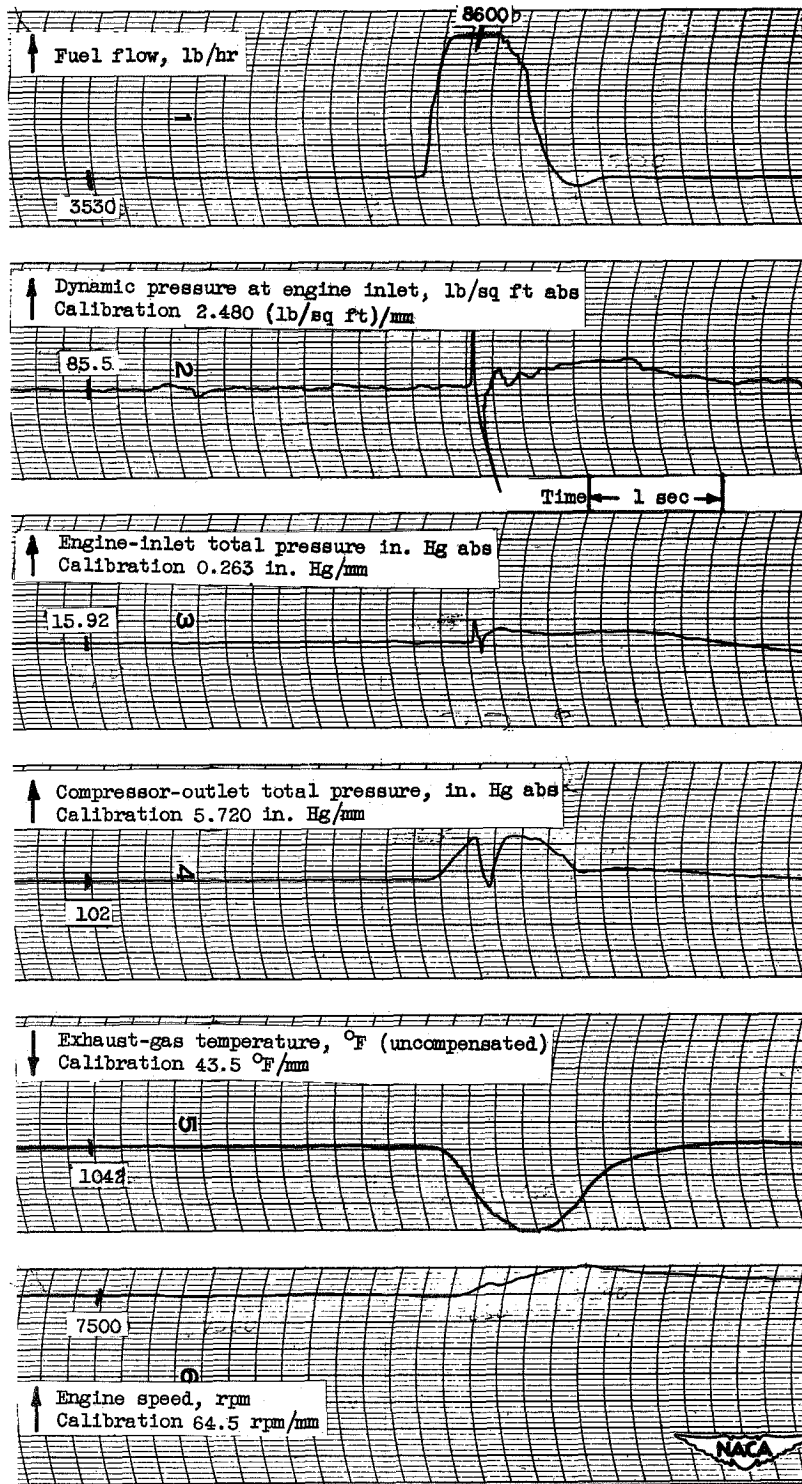


Figure 141

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 35° F; inlet guide vanes position, open.

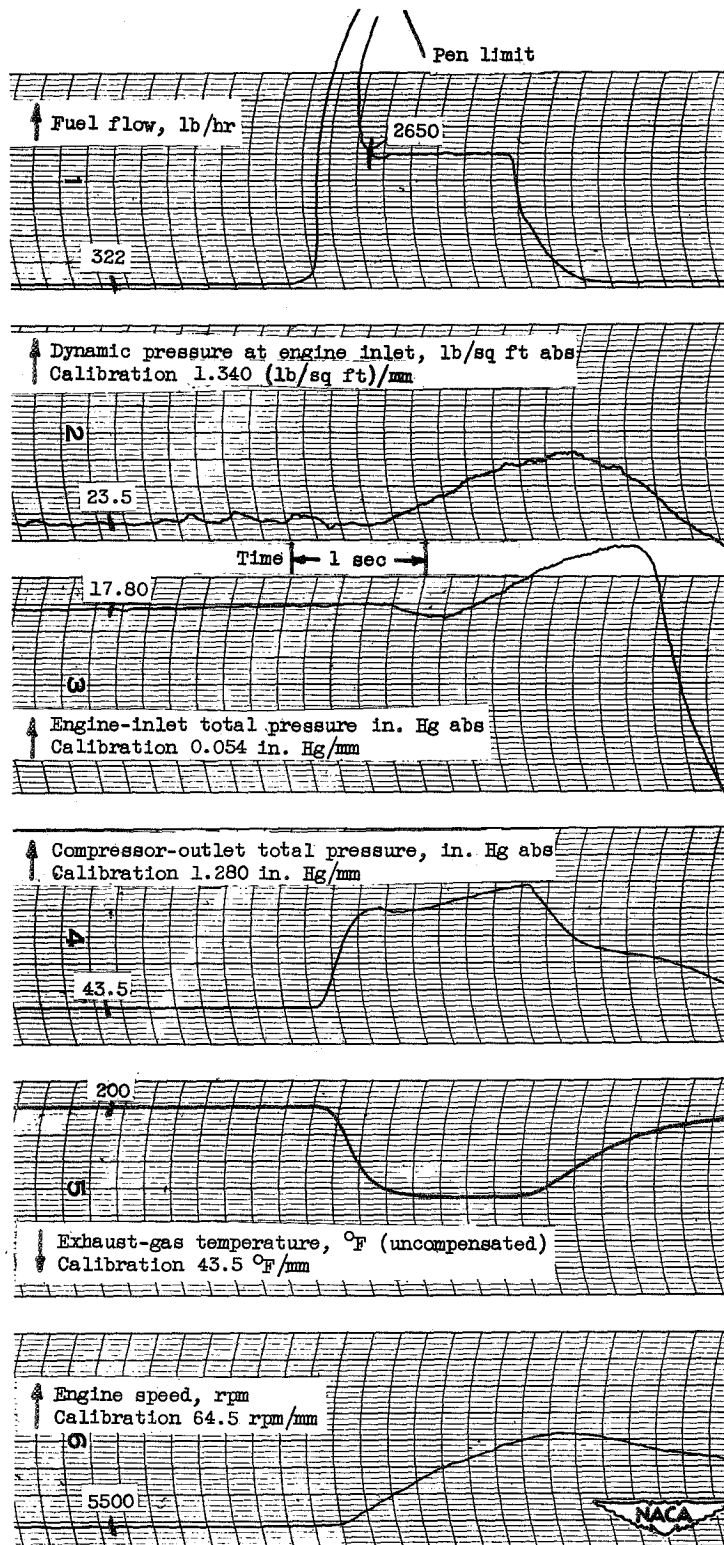


Figure 142
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 30° F; inlet guide vanes position, closed.

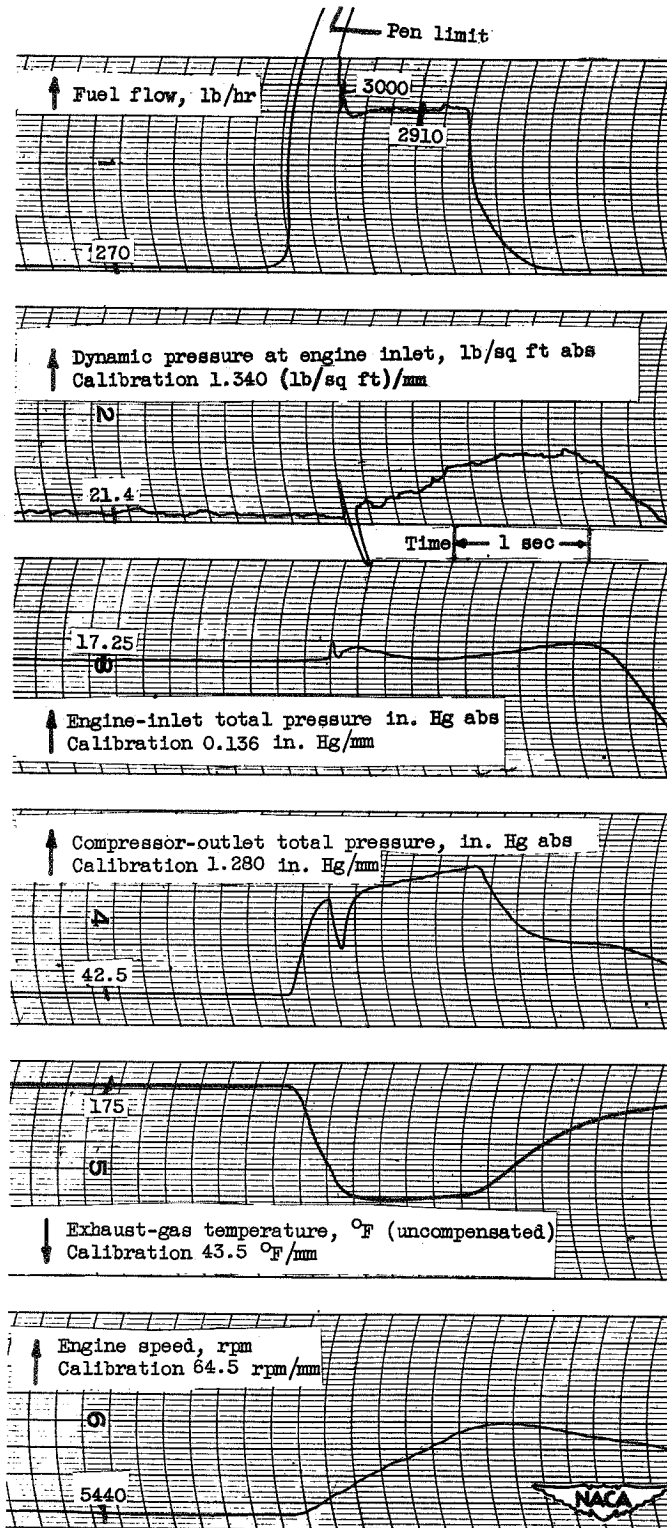


Figure 143
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 30° F; inlet guide vanes position, closed.

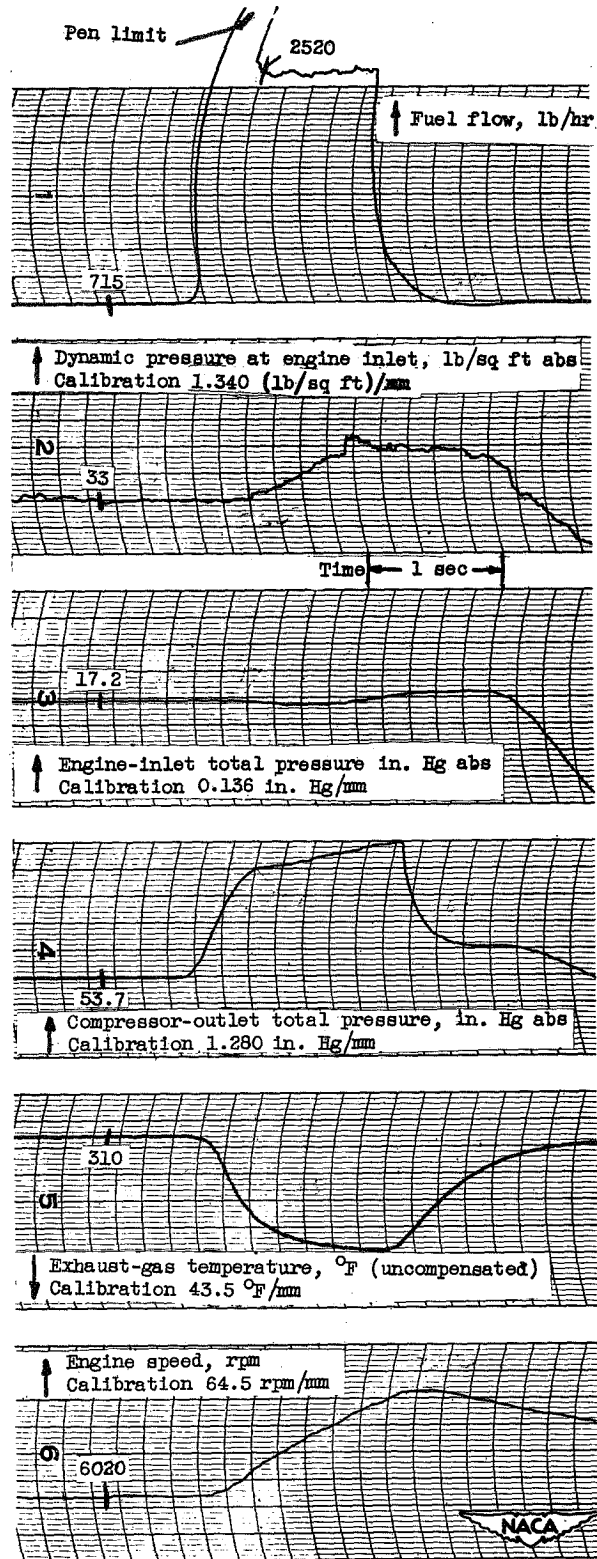


Figure 144
Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 30° F; inlet guide vanes position, closed.

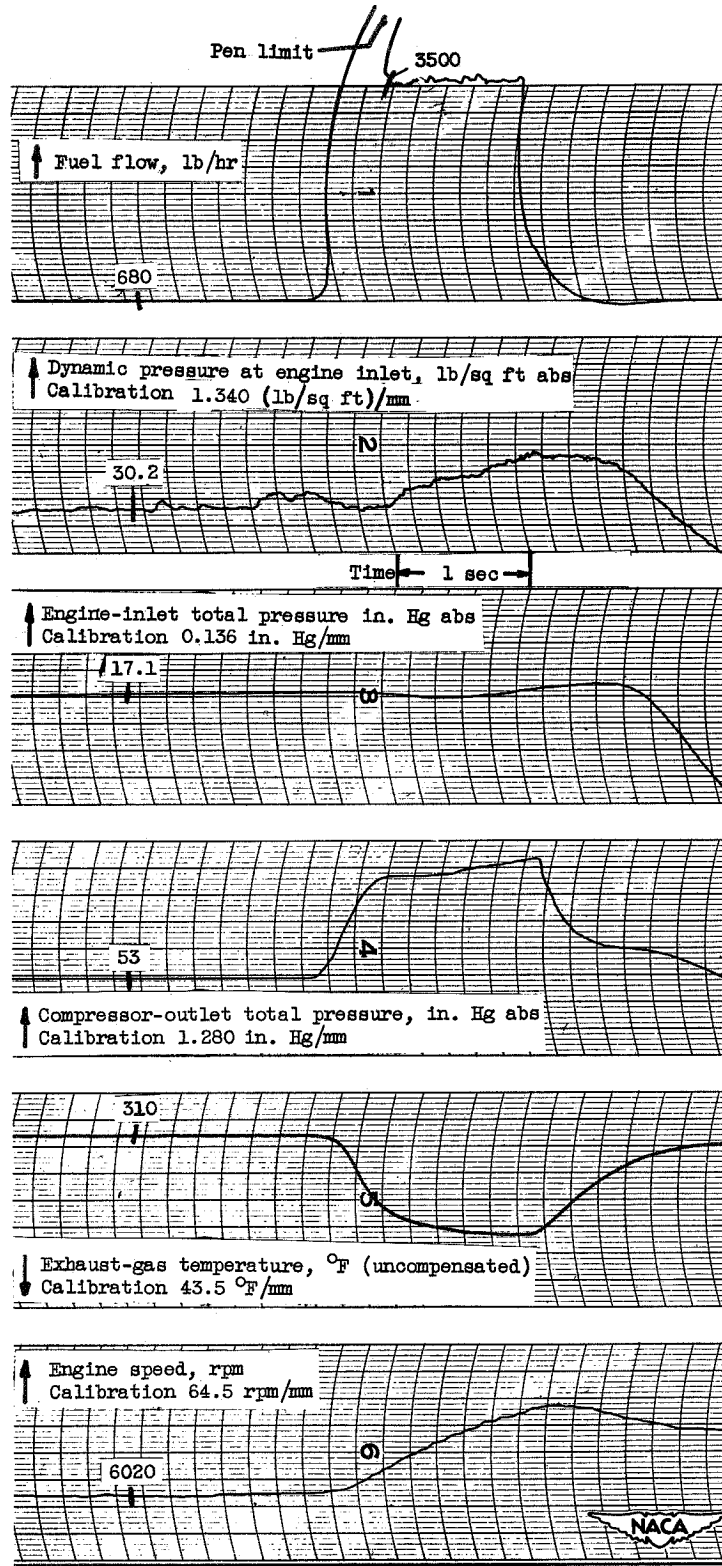


Figure 145

Oscillograph trades showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 29° F; inlet guide vanes position, closed.

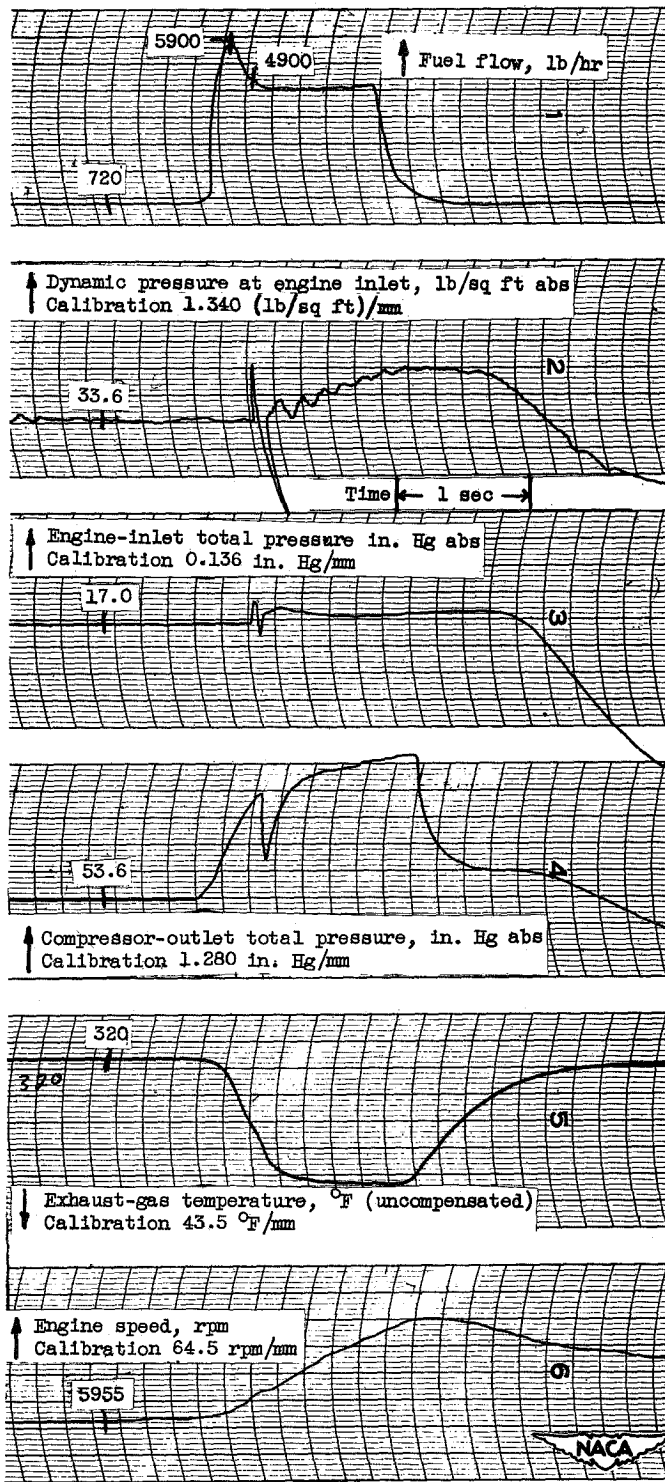


Figure 146

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 30° F; inlet guide vanes position, closed.

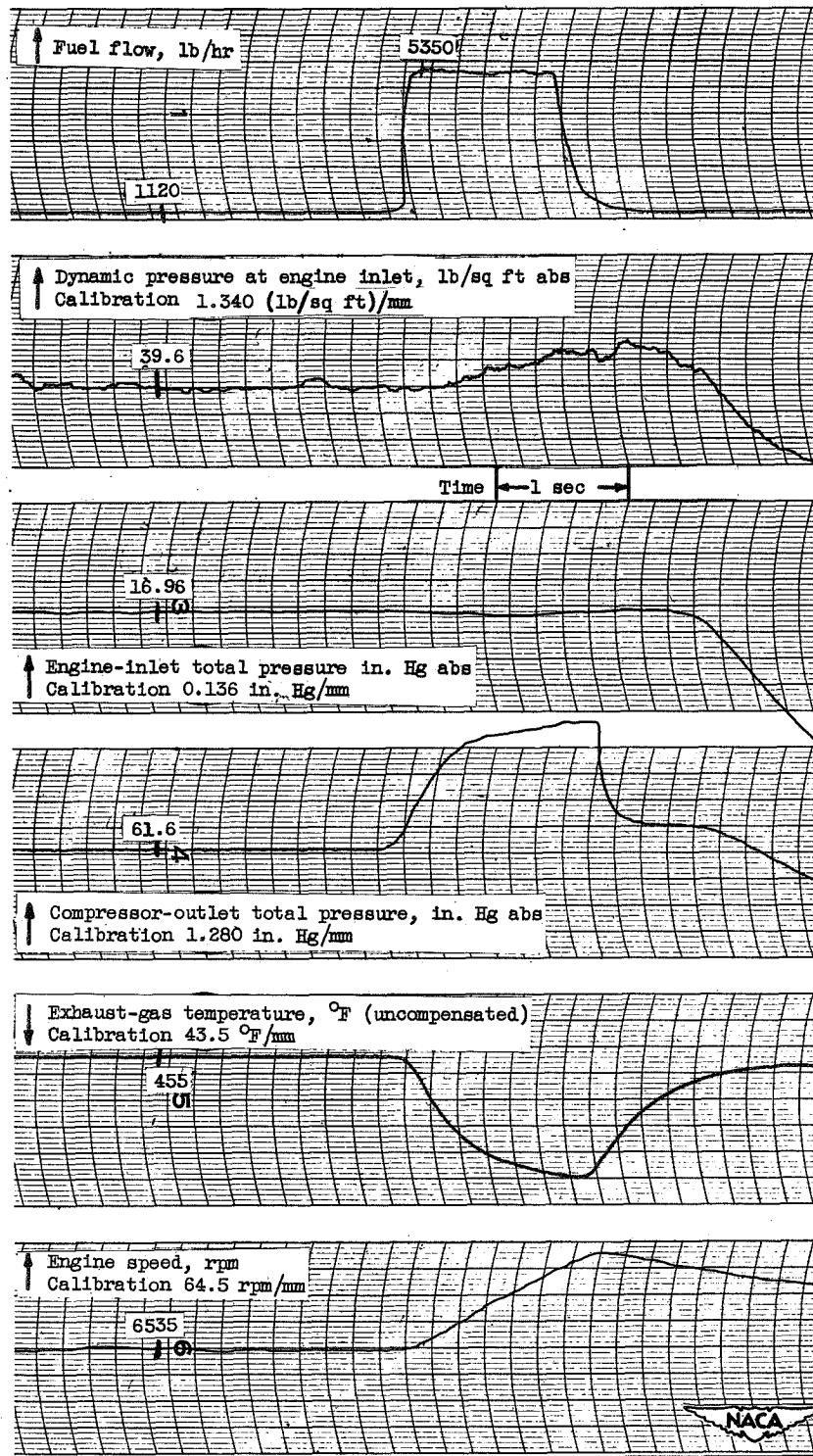


Figure 147

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 30° F; inlet guide vanes position, closed.

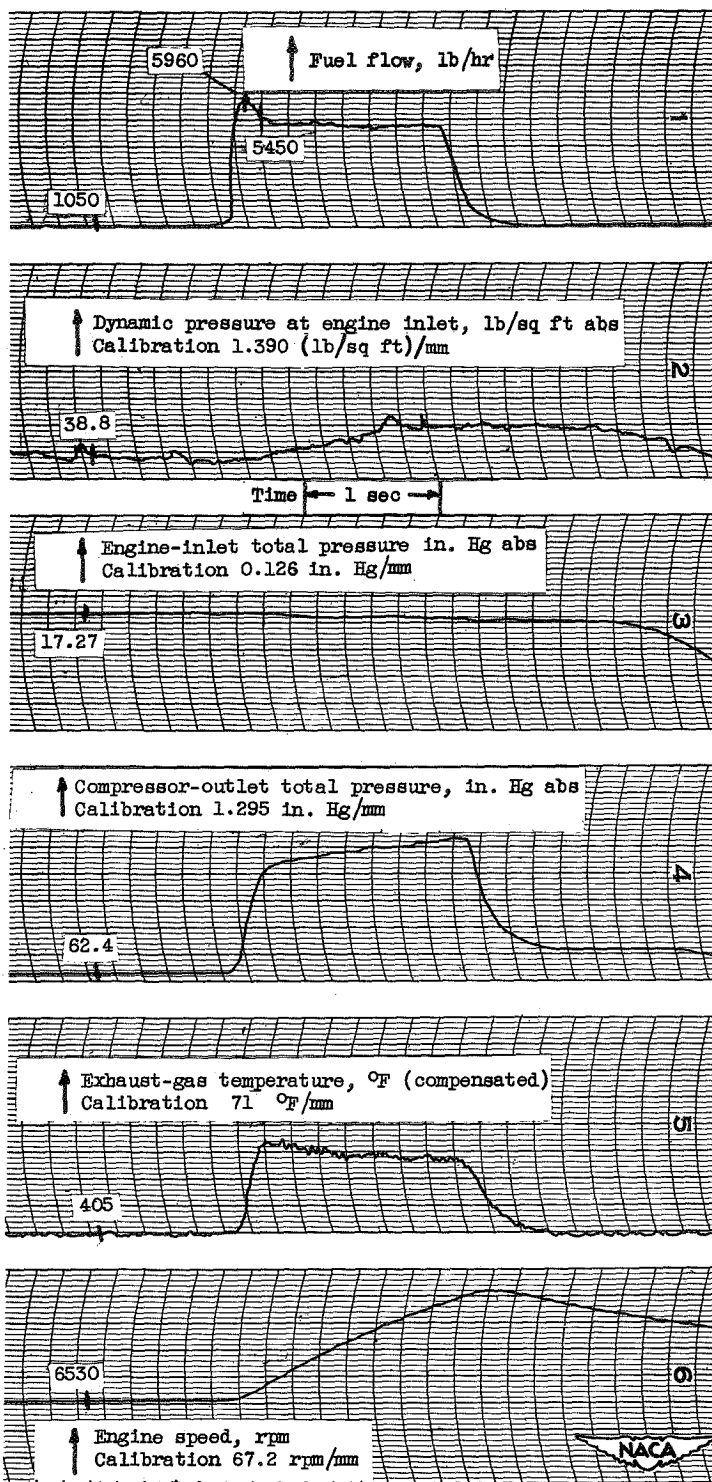


Figure 148

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 40° F; inlet guide vanes' position, closed.

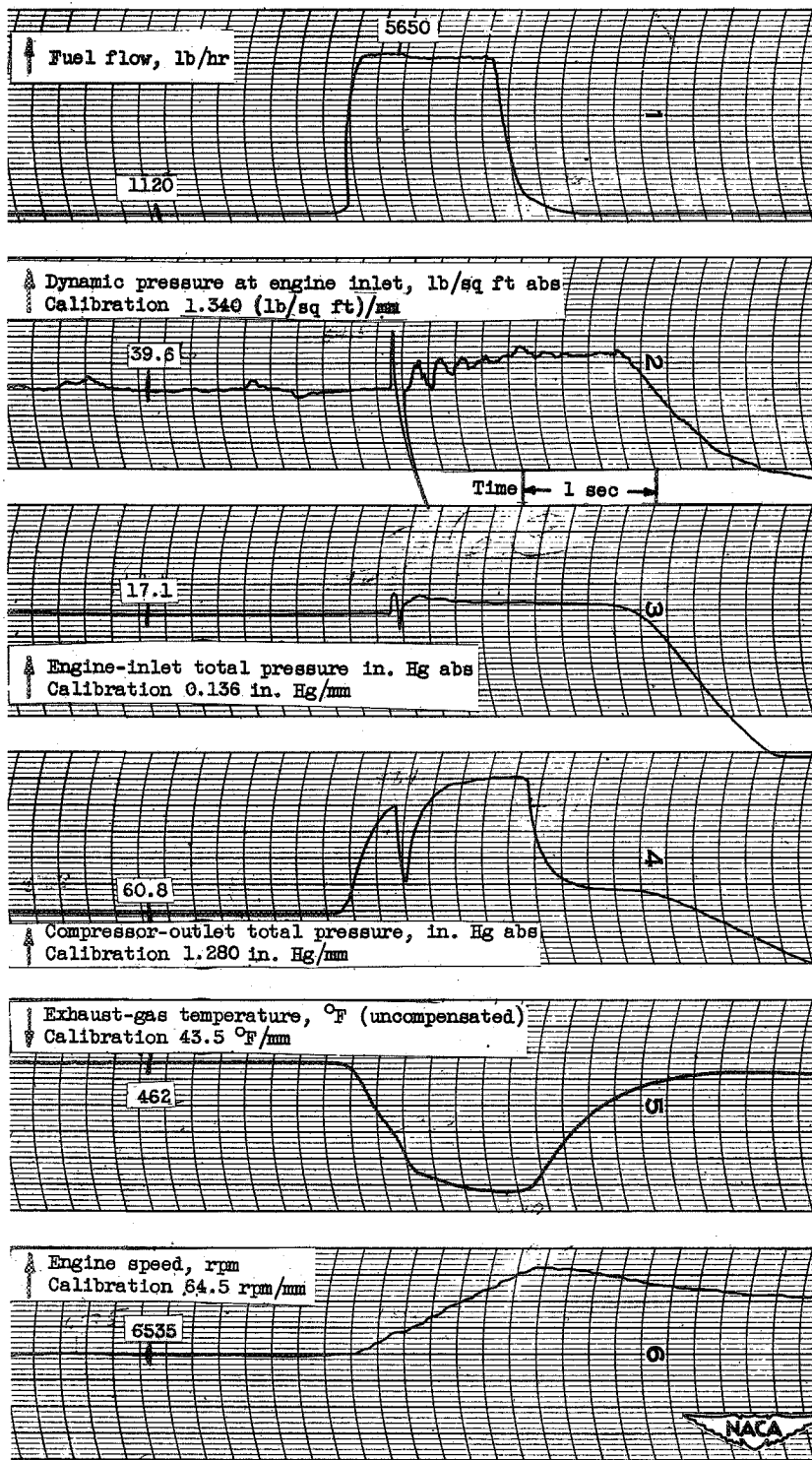


Figure 149

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 30° F; inlet guide vanes position, closed.

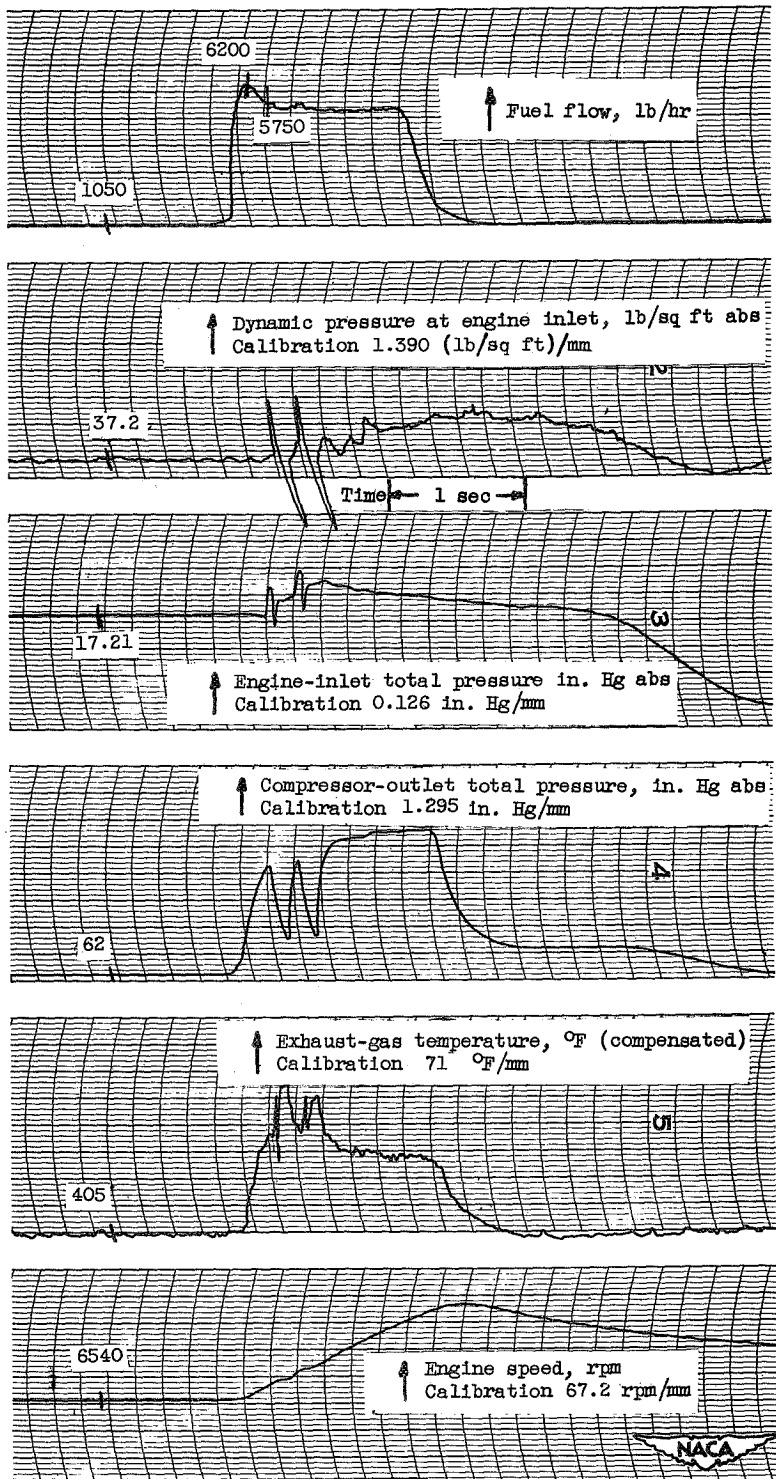


Figure 150

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 40° F; inlet guide vanes position, closed.

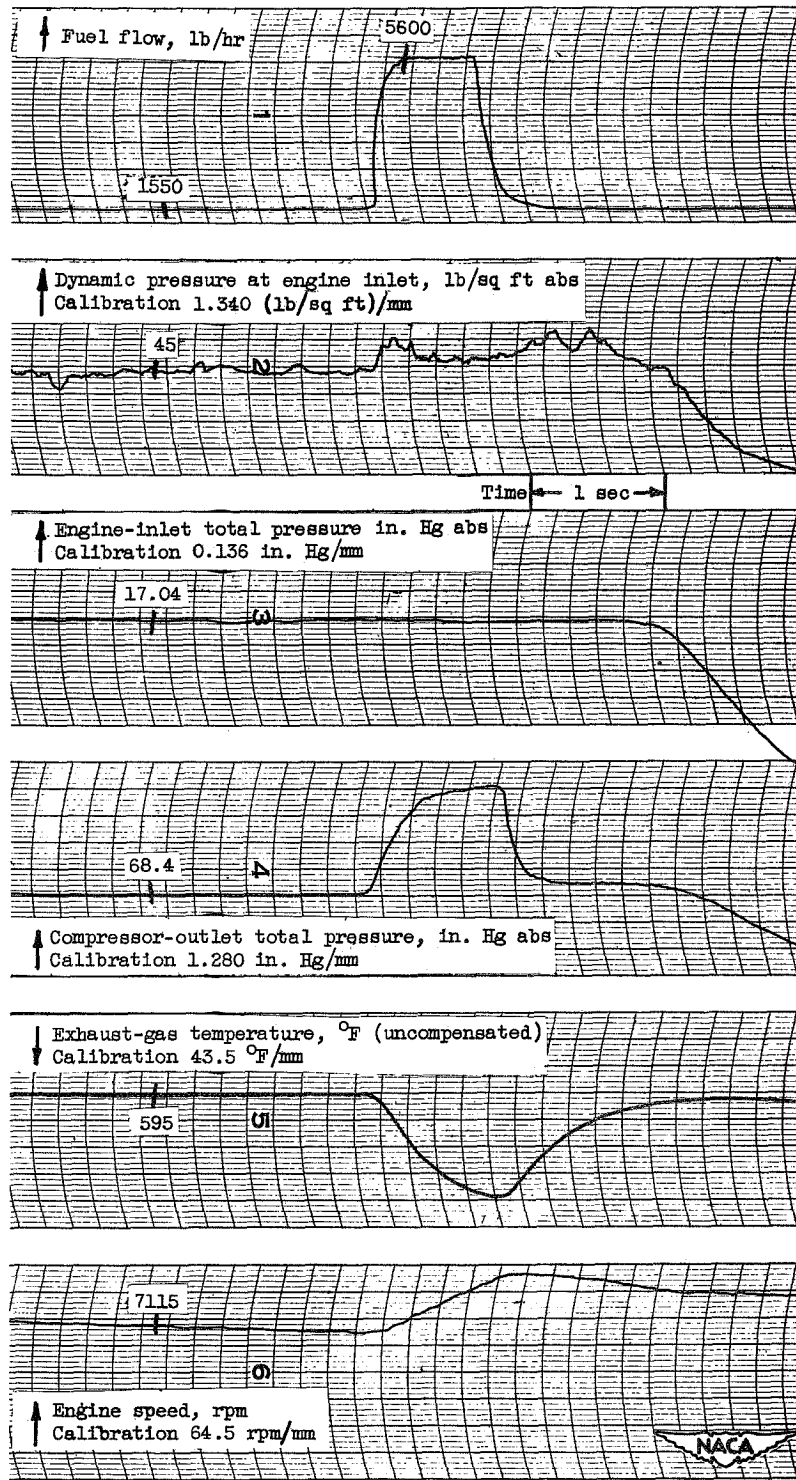


Figure 151

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 30° F; inlet guide vanes position, closed.

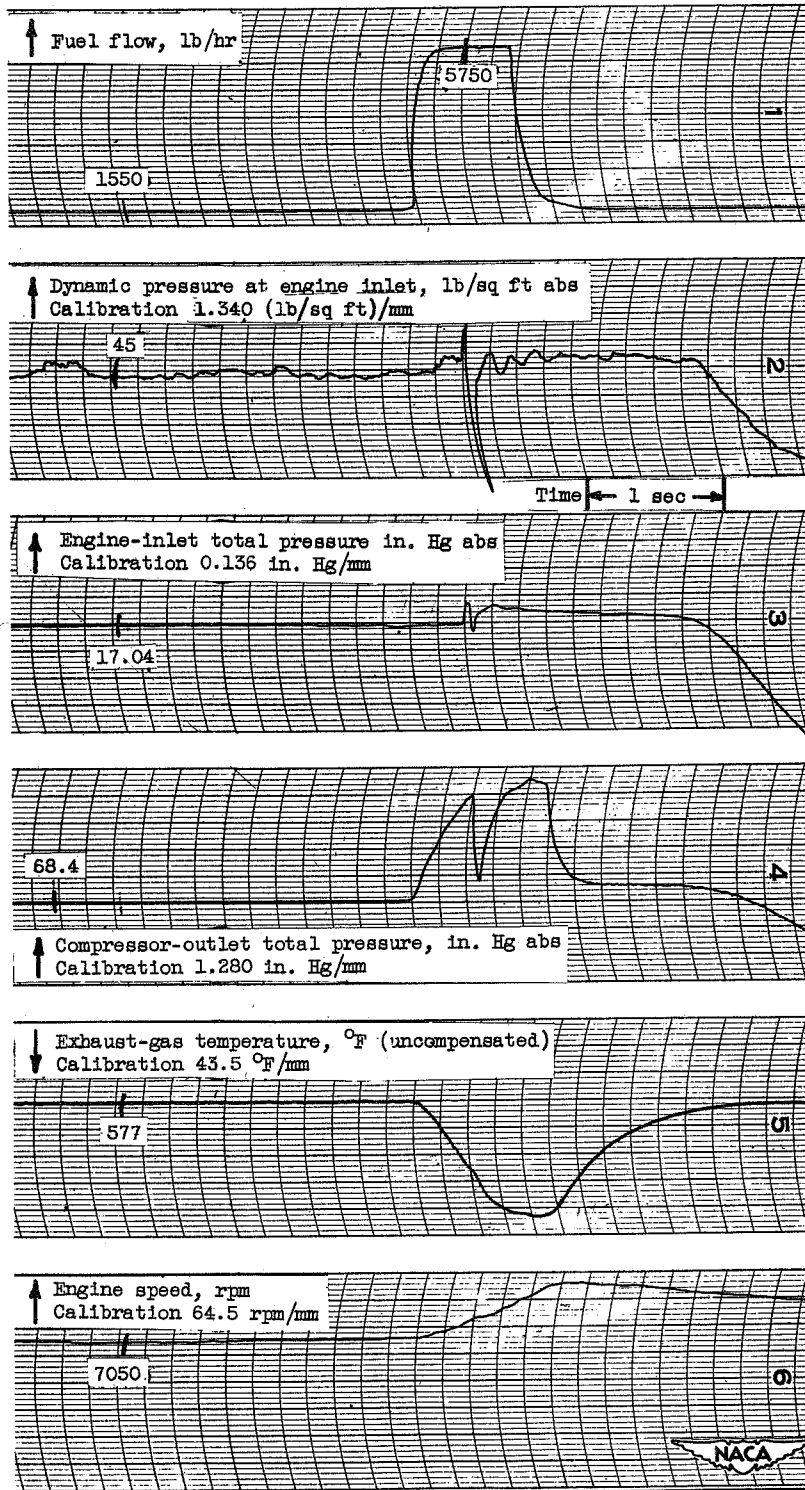


Figure 152

Oscillograph traces showing variations of different engine parameters during a step-change in fuel flow. Altitude, 35,000 feet; flight Mach number, 1.2; engine-inlet air temperature, 30° F; inlet guide vanes position, closed.

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Restriction/
Classification
Cancelled

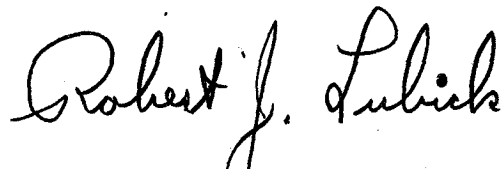
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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

PRELIMINARY TRANSIENT PERFORMANCE DATA ON THE J73 TURBOJET ENGINE

II - ALTITUDE, 35,000 FEET



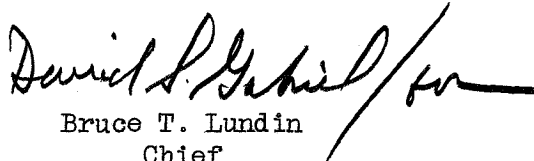
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Classification
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