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JET BLAST FENCE INVESTIGATION AT JOHN F. KENNEDY INTERNATIONAL AIRPORT

Guenther H. Christiansen

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FINAL REPORT

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16. Abstract

A blast fence installed at the departure end of runway 31L at John F. Kennedy International Airport intended to protect aircraft landing on runway 4R from the effects of jet blast was believed to be ineffective. Tests were conducted in two phases. The initial phase was subjective, using smoke to aid in flow visualization. These tests were inconclusive and led to a second phase using instrumentation to determine whether or not a jet blast was present on runway 4R behind the blast fence. Results of phase II confirmed the presence of a jet blast. Tests covered seven aircraft types and indicated maximum blast velocities at runway 4R of 35 miles per hour above ambient wind.

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INTRODUCTION

PURPOSE.

In April 1973, the National Aviation Facilities Experimental Center (NAFEC) was formally requested (by letter from ARD-1) to "evaluate the blast fence efficiency and determine what modifications could reduce the effect (of jet blast) on encountering aircraft." The blast fence evaluated in this report (figures 1 and 2) is located at the approach end of runway 31L at John F. Kennedy (JFK) International Airport and is intended to protect runway 4R arrivals from the effects of jet blast caused by aircraft beginning takeoff on runway 31L.

BACKGROUND.

With the introduction of wide-bodied jet aircraft and high-thrust-line engine mounts, complaints and unsatisfactory condition reports (UCR's) were received linking turbulence encountered by aircraft landing on runway 4R with the blast fence and departing aircraft. This fence is approximately 350 feet long, 10 feet high, and canted approximately 30° to the centerline of runway 31L at the approach end. Canting was required to permit the fence to present a small profile thereby minimizing its effect on the ILS glide slope radiation pattern. As an ultimate consequence of the complaints, procedures were issued which severely restricted the simultaneous use of runways 4R and 31L. This particular runway combination (the best configuration from the standpoint of noise control procedures) was heavily used, and its loss adversely affected airport usage and noise abatement. For these reasons, the Port Authority of New York and New Jersey and the Federal Aviation Administration's (FAA's) Eastern Region were anxious to determine the facts, and if possible, to remove the restrictions.

An initial review of the information available revealed that there were few hard facts and a great deal of subjective opinion. An examination of the complaints disclosed no clearly defined link between the encountered turbulence and the blast fence. Consequently, a test program was conceived involving a subjective initial phase (phase I) to locate and define the turbulence source. Concurrently, scale-model tests in the NAFEC low-turbulence wind tunnel were undertaken. This first phase would be followed by a more detailed and objective measurement program (phase II), if warranted.

TEST DESIGN AND PROCEDURES

PHASE I--FLOW VISUALIZATION TESTING.

Phase I began with exploratory tests on the blast fence using smoke generated by a flow-visualization system installed on N112, a Convair 880 assigned to NAFEC. Subsequently, a smoke generator was built, and a test matrix was devised using normal aircraft departure traffic to explore a 90° wind-sector centered around and perpendicular to the blast fence, encompassing ambient wind velocities of zero to 25 knots. As an aircraft taxied into position, it was identified, and the smoke generator started. Colored smoke grenades were used as desired to develop additional streamlines (figure 3). When the takeoff roll began, the smoke was carefully observed and photographed from several points for later evaluation. It was felt that this technique would expose any organized flow likely to persist into the path of an aircraft landing on runway 4R. Along with wind velocity and aircraft identity data, time, temperature, and humidity were recorded as well.

In addition to the full-scale testing at JFK, one-twelfth scale models of the blast and backup fences were constructed and tested in the low-turbulence wind tunnel at NAFEC. The flow streamlines were explored by a smoke-flow visualization system analogous to the full-scale testing at JFK. Also tested were several modifications to the blast fence structure.

PHASE II--JET BLAST VELOCITY AND TEMPERATURE MEASUREMENT.

The primary objective of this phase was to provide data from which it could be determined whether or not there was any jet blast detectable at the edge of runway 4R when runway 31L was being used for departures. A basic premise was the assumption that jet blast could be considered present if:

1. An increased wind velocity over ambient could be detected;

2. An increased temperature could be detected; and

3. The wind velocity and temperature increases were coincident and were detected within the ambient wind flow transport time--measuring time from the application of power to the time of first detection at the sensor line.

With these considerations, an instrumentation system (figure 4) was designed and constructed utilizing a Gill model 27100 propeller anemometer for wind measurement and a thermistor bridge for temperature measurement. The recording device was an Incre-data Mark II-A incremental digital tape recorder. The anemometer and thermistor were mounted on 3-inch polyvinylcloride (PVC) tubing (figure 5), which could be easily mounted at heights of 5 to 20 feet above the ground in 5-foot increments. Thirteen such poles were used in a sensor line 600 feet long with 50-foot spacing (figure 6). Since the pole-mounted sensors

were only 20 feet tall, arrangements were made to mount additional sensors on three different vehicles, each capable of lifting a sensor to a 60-foot height (figure 7).

Data was to be collected whenever runway 31L was in use. The low sensors were all placed at an elevation of either 10, 15, or 20 feet, as chosen on a daily basis. The high sensors were all placed at a height of either 40 or 60 feet, chosen on a daily basis and placed as seemed best at the time of test with respect to existing wind and weather conditions.

RESULTS

PHASE I--FLOW VISUALIZATION TESTING.

During phase I, the effects from a total of 93 departures were observed in ambient winds ranging up to 30 knots in directions varying from 270° to 240°. The center portion of the blast fence was investigated first. The basic flow, diagrammed in figure 8, was substantially as follows: As the smoke-laden flow entered the blast fence, it was deflected upward, curled over the top of the fence, then entered an atmospheric eddy which was trapped between the blast fence and the backup fence. Flow from this eddy spilled out over the top and around the ends of the backup fence. Smoke entering near the top of the blast fence curled over the top of the trapped eddy, and entered a second eddy trapped immediately behind the backup fence. This flow subsequently mixed with the free wind-stream, as did the flow from the eddy between the fences.

In addition to the basic flow, there exists a strong lateral flow between the blast fence and the backup fence. This component is an effect related to the skew of the blast fence with respect to the runway centerline, and is quite strong. No other motion except that of the turbulent free wind-stream mixed with smoke was observed.

Minor differences related to atmospheric stability were noted in the flow pattern. While no stability measurements were taken, it was quite clear that when conditions were favorable for the formation of atmospheric convection currents, much more smoke was carried aloft from behind the blast fence than without the convection currents. When this occurred, the turbulence associated with the jet blast dissipated earlier.

Testing in the wind tunnel at NAFEC indicated that there might be a well defined, horizontally oriented vortex attached to the high ends of the blast fence. This vortex was being generated by the strong shear between the horizontal flow just beyond the fence limits and the vertical flow issuing from the fence confines.

During the next full-scale testing session at JFK, particular attention was paid to the ends of the fence. The vortices were present, though considerably

weaker than expected (figure 9). In addition, the vortex on the south end of the fence was somewhat weaker than that at the north end, possible due to the decrease in height of the south end of the fence. There appeared to be interaction of the vortices with the trapped eddies at the end of the fence, and dissipation of the vortex was rapid.

It was considered possible that under stable conditions and low wind velocities, the vortices might detach from the ends of the blast fence and drift toward runway 4R, and thus become the source of the reported turbulence. This consideration prompted testing of modifications to the wind tunnel model, designed to cause early breakdown of the vortex, or to prevent formation of the vortex at the end of the blast fence by blocking interaction of the flows. The most promising of these modifications consisted of blocking the flow through a short section at each end of the blast fence, except for a narrow horizontal opening or "slot" near midheight. This blockage was accomplished by means of two flat plates attached to the sloped surface of the fence (figure 10). The slot permitted flow through three passages between the vanes. The combined blocking effect of the plates and the vertical flow issuing from the slot was very effective in introducing turbulent flow near the fence for blast deflection. As a precautionary measure, it was recommended that this modification be accomplished, though there was no clear-cut indication that the fence tips were the source of the difficulty. This modification was accomplished prior to the phase II testing, and the blast fence as tested during phase II was modified.

Careful observation of the blast fence during the phase I tests, and of film records thereafter, failed to disclose any deficiencies, other than the tip effect. A letter report to this effect was issued. Subsequently, objections were raised that these tests permitted observation of the boundaries of the flow only, and that interior effects were masked by the large volume of smoke generated. Further, attention had been concentrated on the blast fence itself, when it was blast effects on runway 4R which were the crux of the requirement. For these reasons and because of the possibility that the blast from high, tail-mounted engines may not have become entrained in the smoke at all, phase II was implemented.

PHASE II--JET BLAST VELOCITY AND TEMPERATURE MEASUREMENT.

During phase II, the effect from a total of 425 departures was monitored during 6 days of testing. These covered eight aircraft types (see table 1 for type and number).

From this total, 146 departures involving the seven most common types were selected for review and analysis. Selection was made to equalize the number of each type and was based upon distance from the fence; one far, one near, and one or two typical for each day. These were then tagged with a run number, in order of date and time, and were so identified wherever required.

TABLE 1. AIRCRAFT DEPARTURE TRAFFIC BY TYPE AND DATE

	Date						
Type	12/3	12/4	12/5	12/9	12/10	12/11	Total
B707	18	25	20	20	22	28	133
DC8	13	14	15	15	11	15	83
L1011	4	6	6	4	5	5	30
DC9	2	7	3	11	7	7	37
B727	10	11	7	17	8	14	67
B747	5	9	8	10	9	8	49
VC10	1	2	-	-	1	1	5
DC10	3	4	3	3	4	4	21
Total	56	78	62	80	67	82	425

Of the 146 departures selected for review, 126 yielded useful data. The remainder were not useful for one reason or another; the biggest data loss being with the L1011. The primary factor in this loss was the departure technique used by the L1011 which involved a prolonged application of partial power prior to breakaway for the takeoff roll. As a result, the onset of the jet blast at the sensor line was not easily identifiable. Therefore, runs which exhibited this characteristic were not included in the analysis and, along with runs excluded for other reasons, are marked with an asterisk in table 2.

The recorded data was reduced in a PDP-11 computer and displayed graphically on an oscilloscope screen. The graph was copied and subsequently assessed manually to determine whether or not jet blast was present. If so, then time of duration (t) (measured from onset to return to ambient) was evaluated, as was the peak velocity increase (ΔV_m) and peak temperature increase (Δ T). The results are compiled in the appendix (Blast Velocity--Time Data). A typical partial computer output for 4 of the 16 sensors is shown in figure 11. Four of these output sheets were required to display all the data from one run. Ambient wind values were removed by averaging the wind and temperature values for the 15 seconds prior to power application at the aircraft. These average values were then used as a base value and indexed as shown in figure 11. Both wind and temperature were sampled at 1-second intervals, with wind shown as a solid line, with straight segments between points, and temperature as a line of dots.

The data collected during phase II shows a substantial number of instances where jet blast from aircraft departing on runway 31L carried over to runway 4R. The appendix contains a tabulation, by aircraft, of the maximum wind velocity increase above ambient found on each run. This appendix also gives the duration of the wind increase and the maximum temperature increase noted. Table 3 gives a summary of the maximum and minimum values for wind velocity increase, duration, and maximum temperature increases along with the mean value for each.

The aircraft showing the greatest blast effect was the DC10, with a mean value of 25 miles per hour (mi/h) for 35 seconds. Twenty-one DC10 departures were monitored; 19 yielded useful data. In only one instance was blast effect not noticed.

The L1011 was next most severe, yielding mean values of 22 mi/h for 40 seconds. Twenty-one L1011 departures were monitored; 13 yielded useful data. Of these 13, 2 failed to show any effect at the sensor line. Much of the lost data was due to an unanticipated operational characteristic displayed by the L1011's. Nearly all were held in takeoff position for quite long periods with partial power applied prior to breakaway. This compromised both the observers' ability to define the run start, and the ability of the data reduction system to define the point of departure from ambient. In spite of this, enough data was obtained to substantiate the values quoted in the appendix.

TABLE 2. SELECTED RUNS

Date : December 3, 1974
Wind : 320/20
Temp. : 40°F
Sensors: Lo 10 Hi 40

Run No.	Time	Type	Dist.
1	09:19:30	L-1011	-
2	:37:19	DC-9	235
3	:41:13	B-747	230
4	:46:10	B-727	220
5*	:48:12	L-1011	130
6*	:49:56	B-707	040
7	:58:24	B-727	285
8	10:00:02	DC-10	195
9	:03:46	DC-9	180
10	:05:11	B-707	355
11	:09:33	DC-10	310
12	:12:36	B-727	115
13	:13:48	DC-10	160
14*	:19:48	B-707	255
15	:23:52	B-747	095
16*	10:29:55	DC-8	130
17	:44:01	DC-8	210
18*	:49:43	B-747	175
19	:50:27	L-1011	180
20*	11:31:09	DC-8	305

Date : December 4, 1974
Wind : 320/17
Temp. : 32°F
Sensors: Lo 10 Hi 40

Run No.	Time	Type	Dist.
21*	08:59:18	DC-8	070
22	09:18:40	L-1011	-
23	:24:48	B-707	230
24	:33:03	L-1011	165
25	:37:08	DC-9	270
26	:44:14	B-727	330
27	:52:40	DC-10	200
28	:57:53	B-727	155
29	:59:45	DC-9	170
30	10:02:17	B-707	220
31	:07:42	DC-10	290
32	:12:44	B-747	280
33	:14:25	DC-10	250
34	:21:09	B-747	085
35	:23:09	DC-8	450
36	:44:10	B-707	125
37	:50:56	B-727	310
38*	:52:56	DC-8	130
39	:57:06	L-1011	220
40	11:00:25	DC-9	250
41	:40:48	B-707	320
42	:48:59	DC-9	320
43	:54:34	DC-10	270
44	12:13:22	B-747	190
45	:15:57	B-747	325
46	:34:20	DC-8	270
47	:40:23	B-727	240
48	:44:25	L-1011	120
49	:46:54	DC-9	290

Date : December 5, 1974
Wind : 360/4
Temp. : 28°F
Sensors: Lo 10 Hi 60

Run No.	Time	Type	Dist.
50*	08:28:13	DC-8	375
51	:36:50	B-727	270
52	:47:50	B-707	125
53	09:14:54	B-707	400
54	:19:24	L-1011	200
55	:22:57	B-727	100
56	:24:15	B-747	355
57	:34:00	DC-9	320
58	:35:16	DC-9	350
59	:52:23	DC-10	550
60	:59:52	DC-9	330
61	10:03:02	DC-8	260
62	:06:45	DC-10	370
63	:10:24	B-727	600
64	:14:00	DC-10	255
65	:15:29	B-707	260
66	:20:26	B-747	310
67	:33:03	B-747	155
68*	:37:45	L-1011	230
69	:44:51	DC-8	160
70*	11:16:47	L-1011	350

Date : December 9, 1974
Wind : 330/15
Temp. : 42°F
Sensors: Lo 20 Hi 40

Run No.	Time	Type	Dist.
71	09:26:20	B-707	130
72	:27:23	L-1011	200
73*	:29:45	L-1011	170
74	:40:43	DC-9	380
75	:43:15	B-747	430
76	:46:22	B-727	140
77*	:58:08	DC-10	310
78	10:07:15	DC-10	265
79	:16:01	B-727	205
80	:24:09	DC-10	250
81	:25:59	B-747	285
82	:31:19	B-707	255
83*	:52:19	L-1011	250
84	:56:28	DC-9	190
85	:59:18	DC-8	170
86	11:22:26	DC-8	550
87	:49:36	DC-8	340
88	:51:55	DC-9	700
89	12:18:48	B-707	400
90	:19:58	B-747	220
91	13:41:14	B-727	350

Date : December 10, 1974
Wind : 300/20
Temp. : 35°F
Sensors: Lo 20 Hi 60

Run No.	Time	Type	Dist.
92	09:12:18	B-707	450
93	:26:07	L-1011	200
94	:29:41	B-747	255
95*	:31:39	L-1011	270
96	:33:19	B-707	330
97	:34:28	DC-9	200
98	:42:36	B-727	170
99	10:07:32	DC-10	300
100	:09:05	B-707	295
101	:18:51	B-707	160
102	:20:45	DC-8	135
103*	:26:33	B-747	500
104	:29:06	DC-10	260
105	:36:02	L-1011	175
106	:39:01	B-727	175
107	:46:16	L-1011	220
108*	:49:24	B-747	120
109	11:01:33	DC-8	450
110	:03:53	DC-9	325
111	:08:19	DC-8	110
112	:15:11	DC-8	700
113	:20:17	B-727	210
114	12:01:27	DC-10	240
115	:08:13	DC-9	240
116	:14:02	B-747	230
117	:39:31	B-727	320
118	:40:57	DC-9	460

Date : December 11, 1974
Wind : 280/10
Temp. : 34°F
Sensors: Lo 15 Hi 40

Run No.	Time	Type	Dist.
119	08:44:29	B-727	090
120*	09:17:47	L-1011	250
121	:30:43	L-1011	100
122	:34:29	B-707	090
123	:45:49	DC-9	040
124	:49:26	B-747	335
125	:55:55	DC-8	075
126	:57:45	DC-10	265
127	:59:52	B-727	300
128	10:01:06	DC-9	170
129	:02:04	B-707	260
130	:09:23	DC-10	200
131	:12:41	DC-10	210
132	:17:11	B-747	190
133	:25:25	B-707	240
134	:29:35	B-727	530
135*	:36:09	L-1011	180
136	:41:44	DC-8	260
137	:43:18	L-1011	245
138	:44:46	B-747	130
139	11:01:52	B-747	380
140	:04:55	DC-9	250
141	:22:15	B-707	370
142	:23:55	DC-8	450
143	:32:29	DC-8	450
144	:42:59	DC-10	355
145	:47:42	DC-9	375
146*	13:14:19	B-727	310

NOTE: *This data was unsatisfactory and not used for the final analysis.

TABLE 3. SUMMARY OF EFFECTS OBSERVED

Factor	Aircraft	Maximum	Minimum	Mean
ΔV_m	DC10	35	13	24.9
	L1011	28	16	22.4
	B747	32	14	20.8
(mi/h)	B727	28	10	16.5
	B707	20	8	14.1
	DC8	20	7	12.5
	DC9	15	8	10.6
	DC10	63	20	35.0
	L1011	63	22	39.7
	B747	53	17	32.2
ΔT	B727	43	9	22.5
(sec)	B707	43	21	30.5
	DC8	60	17	33.2
	DC9	22	11	15.8
	DC10	8	4	5.8
	L1011	6	4	5.6
	B747	8	4	5.6
ΔT	B727	8	2	5.2
(°F)	B707	10	3	5.3
	DC8	7	3	5.5
	DC9	4	2	3.0

Ranking third in the large jets, the B747 showed mean values of 21 mi/h for 32 seconds. Twenty-one B747 departures were evaluated; 18 yielded useful data. Of these 18, only 1 failed to show data at the sensor line.

The remaining aircraft monitored (B727, B707, DC8, and DC9) all showed similar, though smaller, effects. Only the DC9 showed a significant number of runs (13 out of 21) which failed to give any indication of jet blast at the sensor line. It should be noted that every aircraft type monitored showed some jet blast effects at the edge of runway 4R.

Temperature increase was monitored primarily as a means to assist in separating jet blast from gust and thermal effects. The probes were calibrated, and temperature increases at the sensor line on the order of 5° to 7° F were noted. This figure seems to be fairly consistent from aircraft to aircraft, and it is believed that the variations noted are due principally to atmospheric mixing.

Although the primary purpose of the tests was to answer a simple question as to the presence and strength of jet blast on runway 4R, an attempt was made to derive more information by a statistical analysis of the data. Coarse tests attempting to relate jet blast velocity to takeoff position and wind velocity show that the data is too coarse for rigorous analysis. The data does suggest a dependency between jet blast velocity, ambient wind, and the distance to breakaway. The quantity of data, however, is too small to allow this dependency to be well defined, except as follows: (1) Blast is stronger for a heavier aircraft and aircraft closer to the blast fence; and (2) jet blast is stronger during stronger ambient winds. Given that jet blast escapes the blast fence, these relationships were not unexpected.

A similar attempt was made to define the width of the jet blast disturbance along the centerline of runway 4R. Again, it was found that on an individual run, the total number of sensors affected could not be clearly defined. In the aggregate, however, from six to eight sensors were usually involved, indicating a width of 200 to 300 feet.

CONCLUSIONS

From the results, it was concluded that:

1. The blast fence located at the approach end of runway 31L at JFK Airport fails to prevent jet blast from reaching runway 4R in a significant proportion of the departures from nearby runway 31L.

2. Given the proper wind and weather, jet blast may be experienced behind any of the jet aircraft monitored at JFK.

3. The heavy jet aircraft, such as the DC10, L1011, and B747, generate the strongest jet blast. Maximum velocities of 35 mi/h in excess of ambient were experienced.

4. Blast effects were detected for periods up to 63 seconds after full-thrust application for these aircraft.

5. The width of the jet blast disturbance at runway 4R is poorly defined, but is on the order of 300 to 400 feet when the generating aircraft is one of the heavy jets.

FIGURE 1. BLAST FENCE AT RUNWAY 31L, JFK INTERNATIONAL AIRPORT

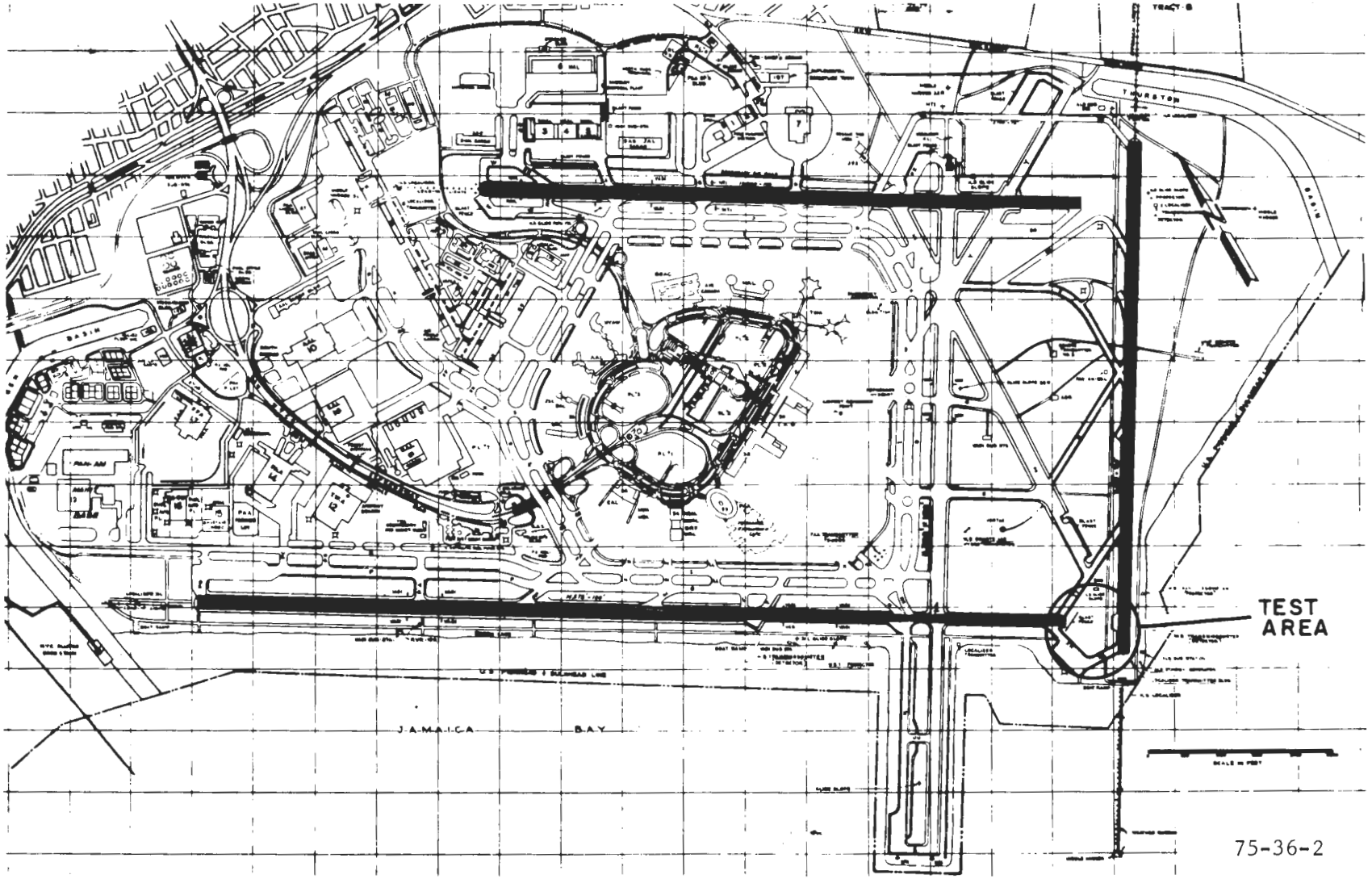

FIGURE 2. JFK INTERNATIONAL AIRPORT

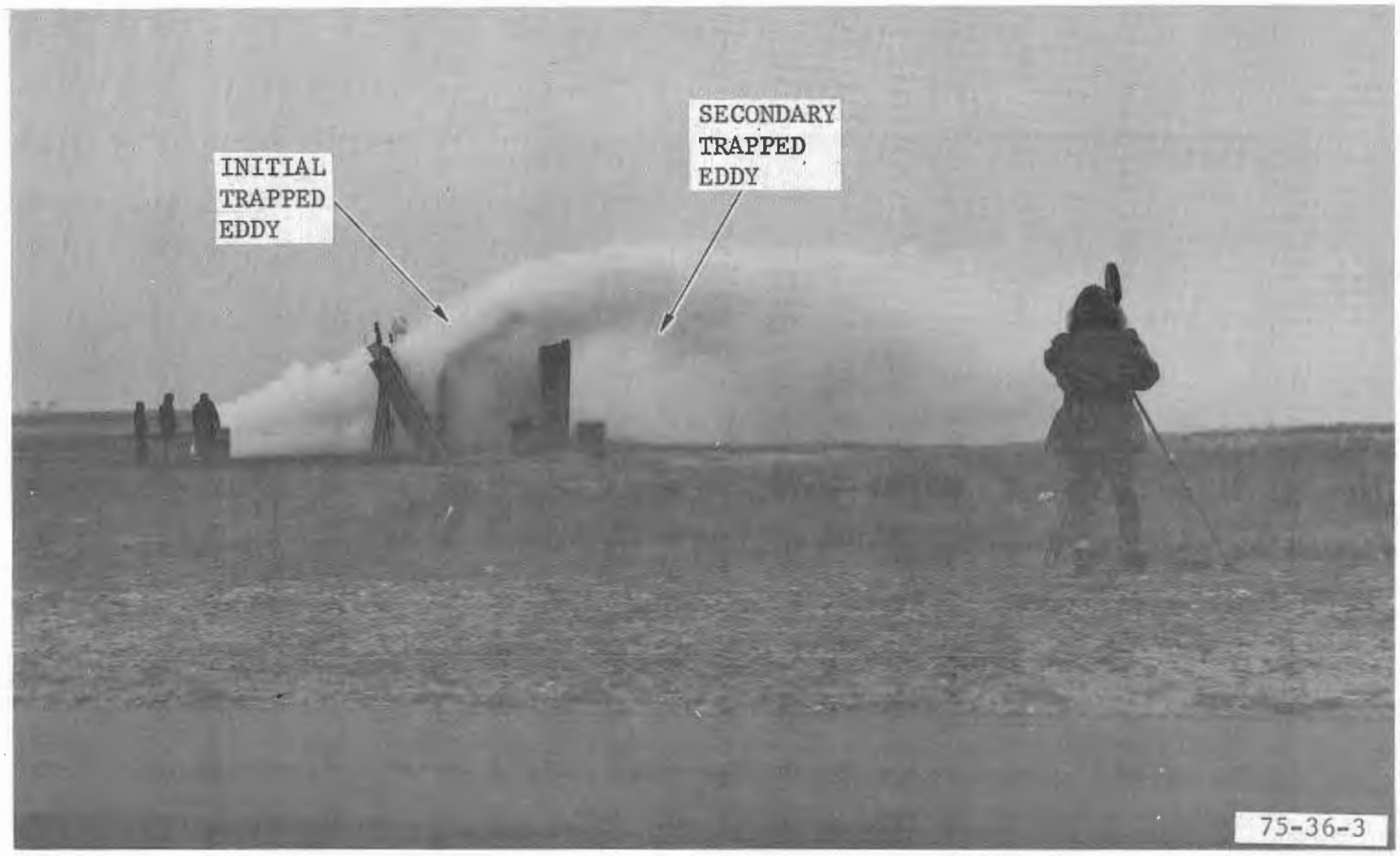

FIGURE 3. TYPICAL SCENE DURING FLOW VISUALIZATION TESTING

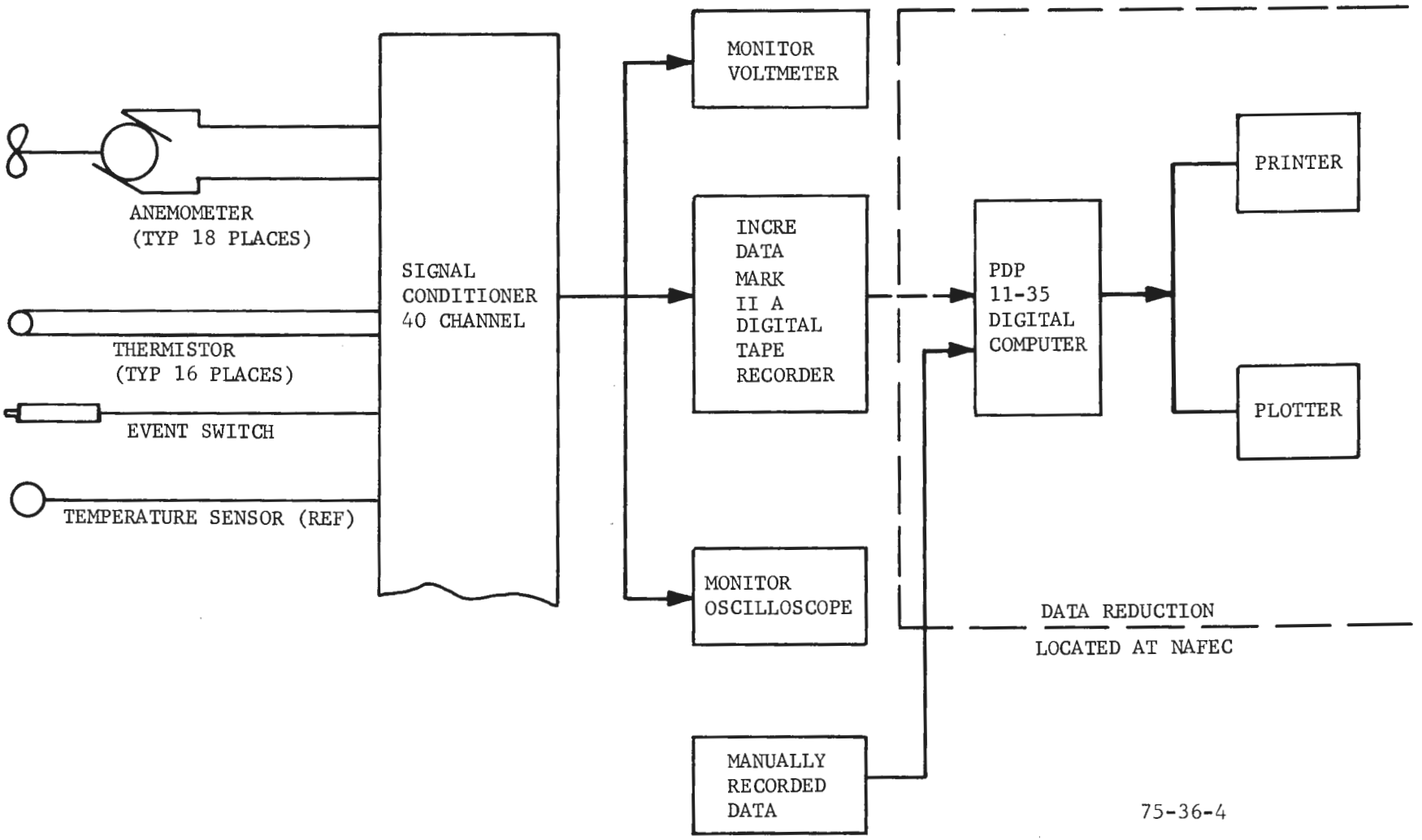

FIGURE 4. INSTRUMENTATION BLOCK DIAGRAM

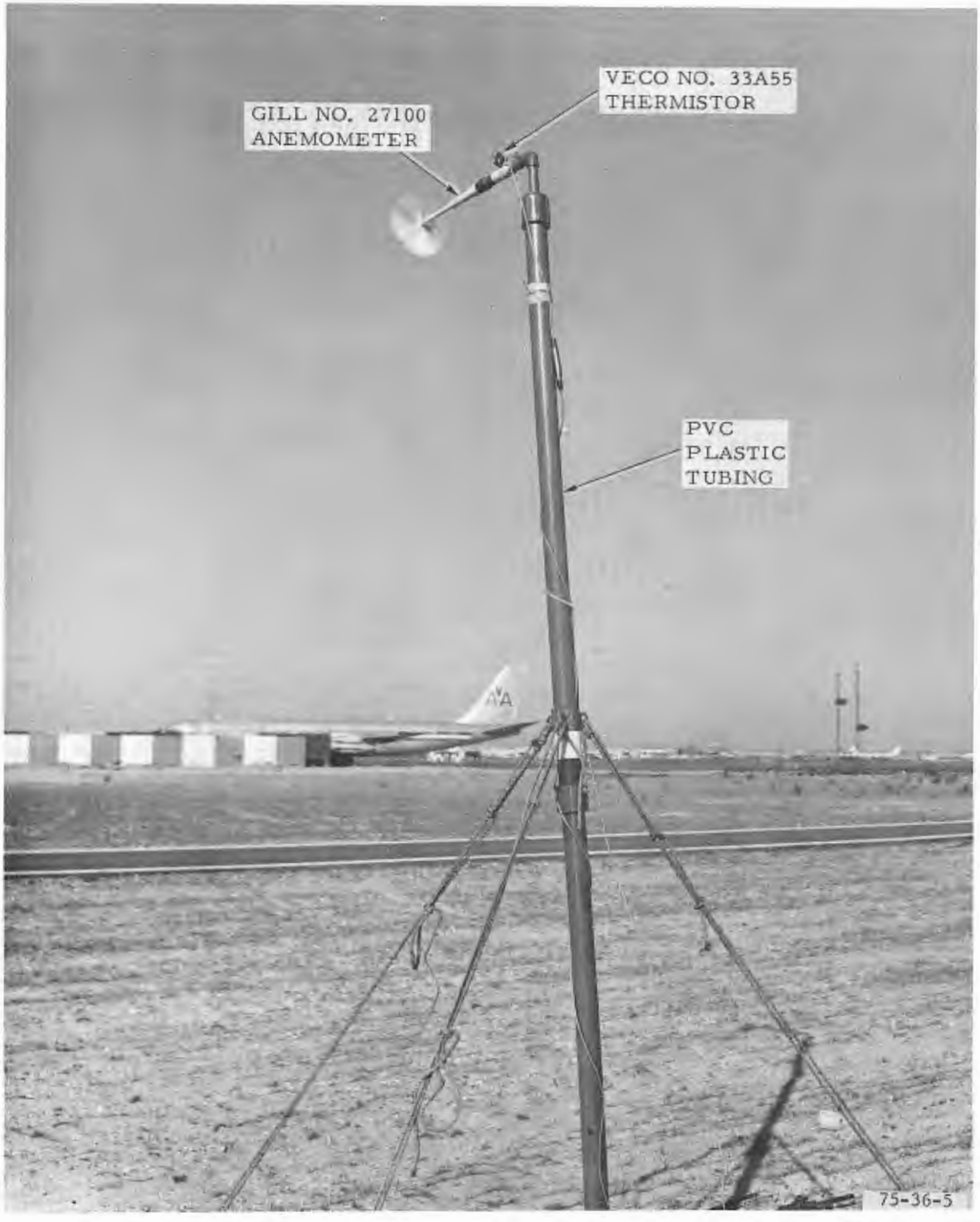

FIGURE 5. TRANSDUCER INSTALLATION AND MOUNT

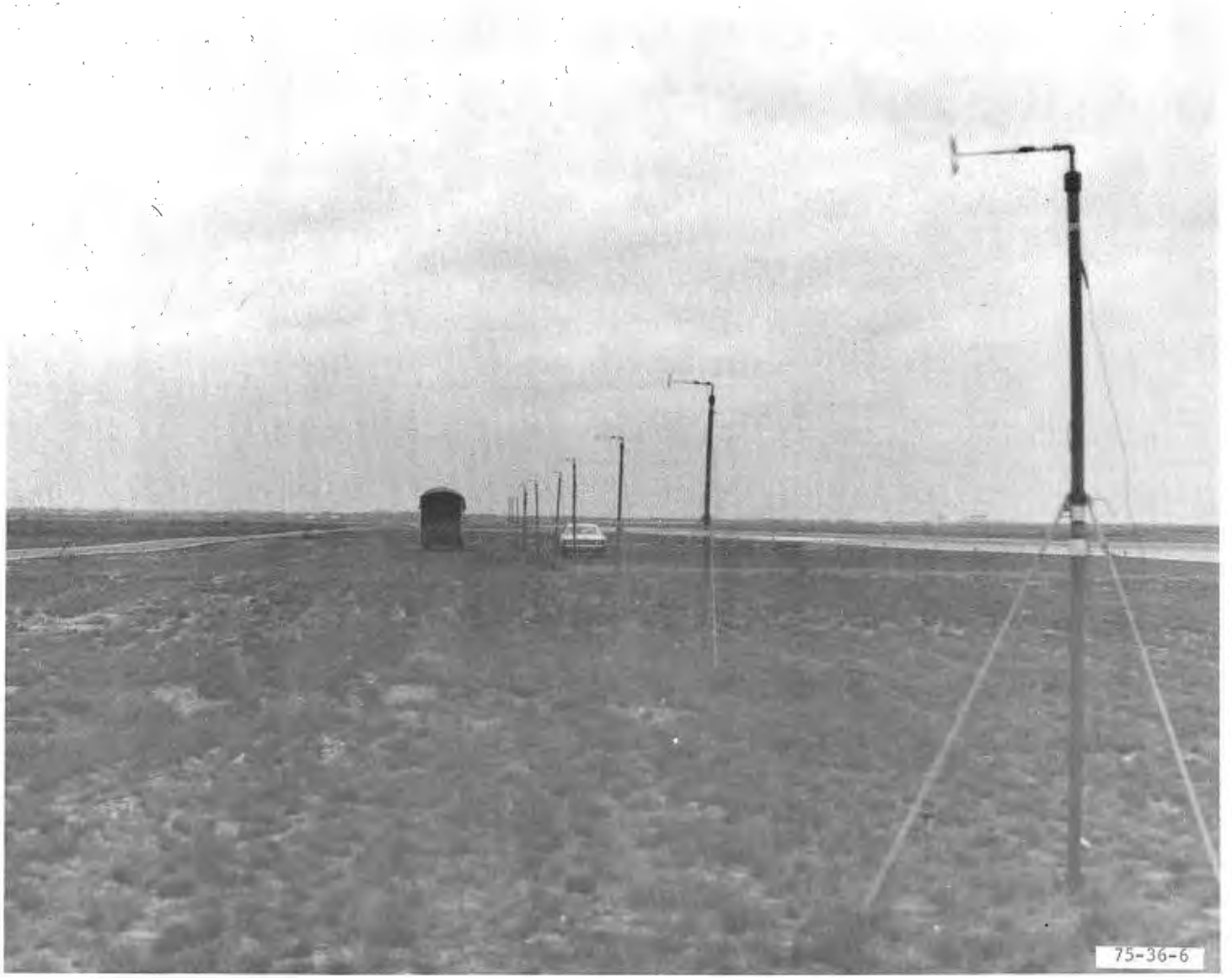

FIGURE 6. SENSOR LINE ON LEFT EDGE OF RUNWAY 4R

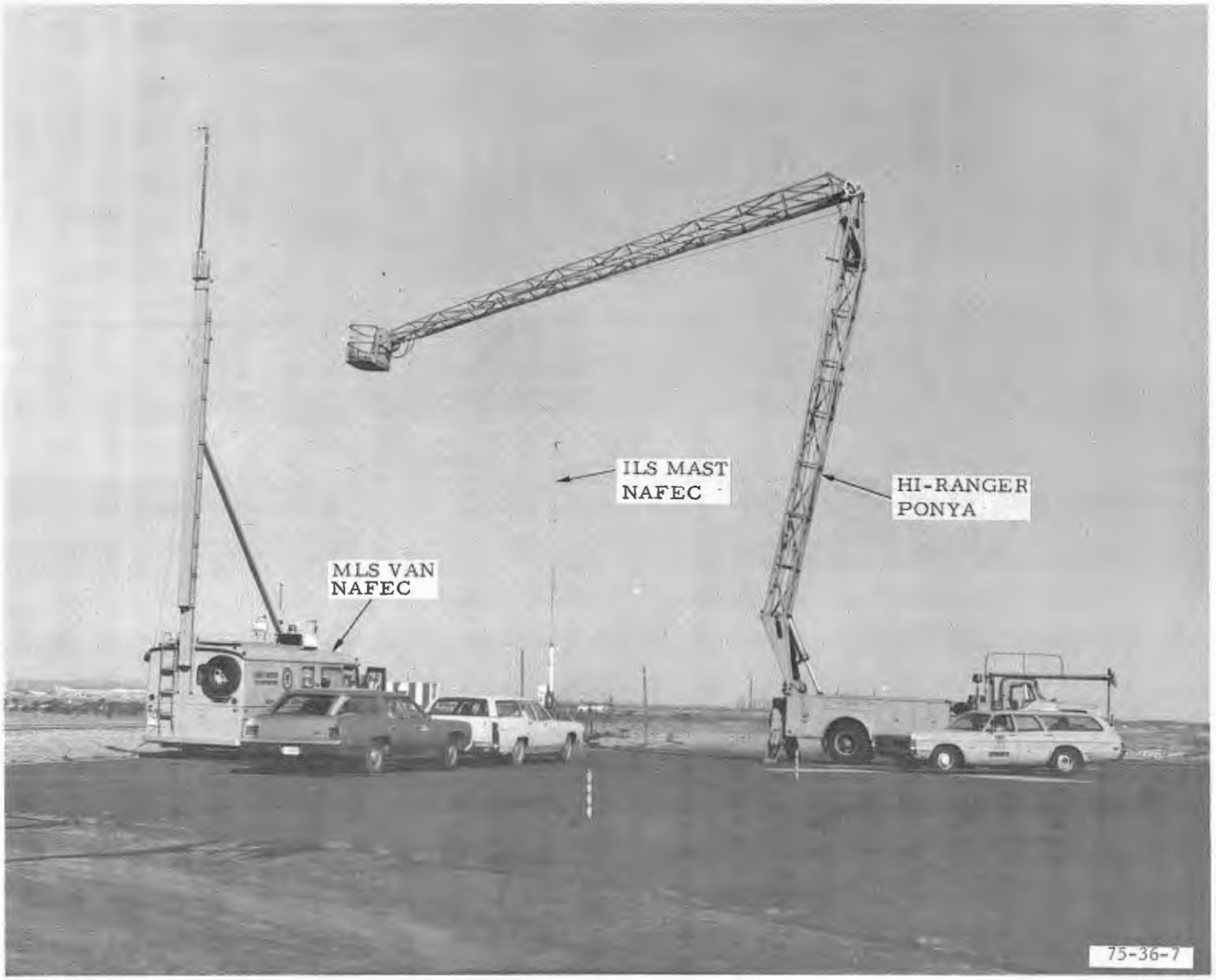

FIGURE 7. RECORDING STATION AND HIGH SENSORS

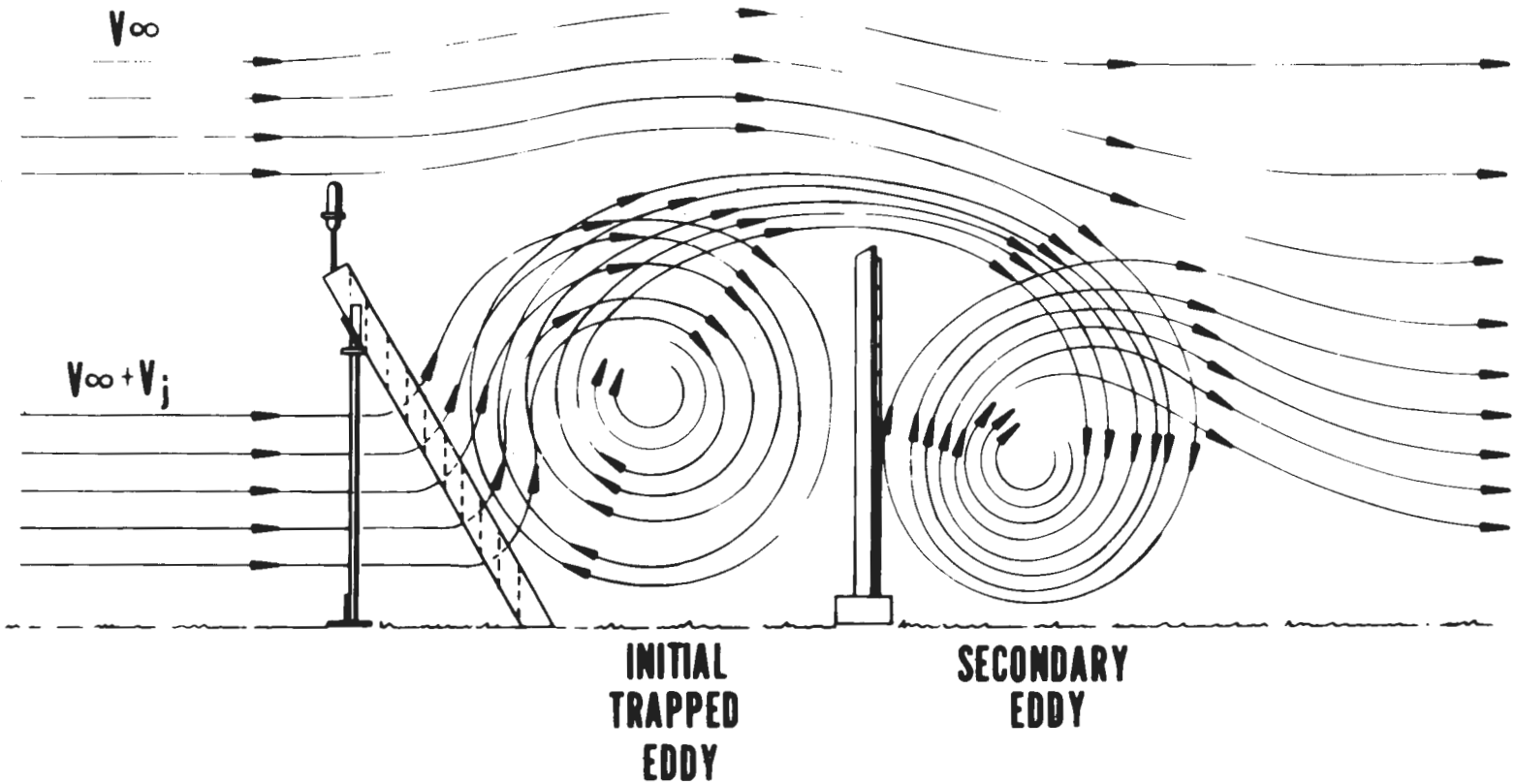

FIGURE 8. BASIC BLAST FENCE FLOW PATTERN

75-36-8

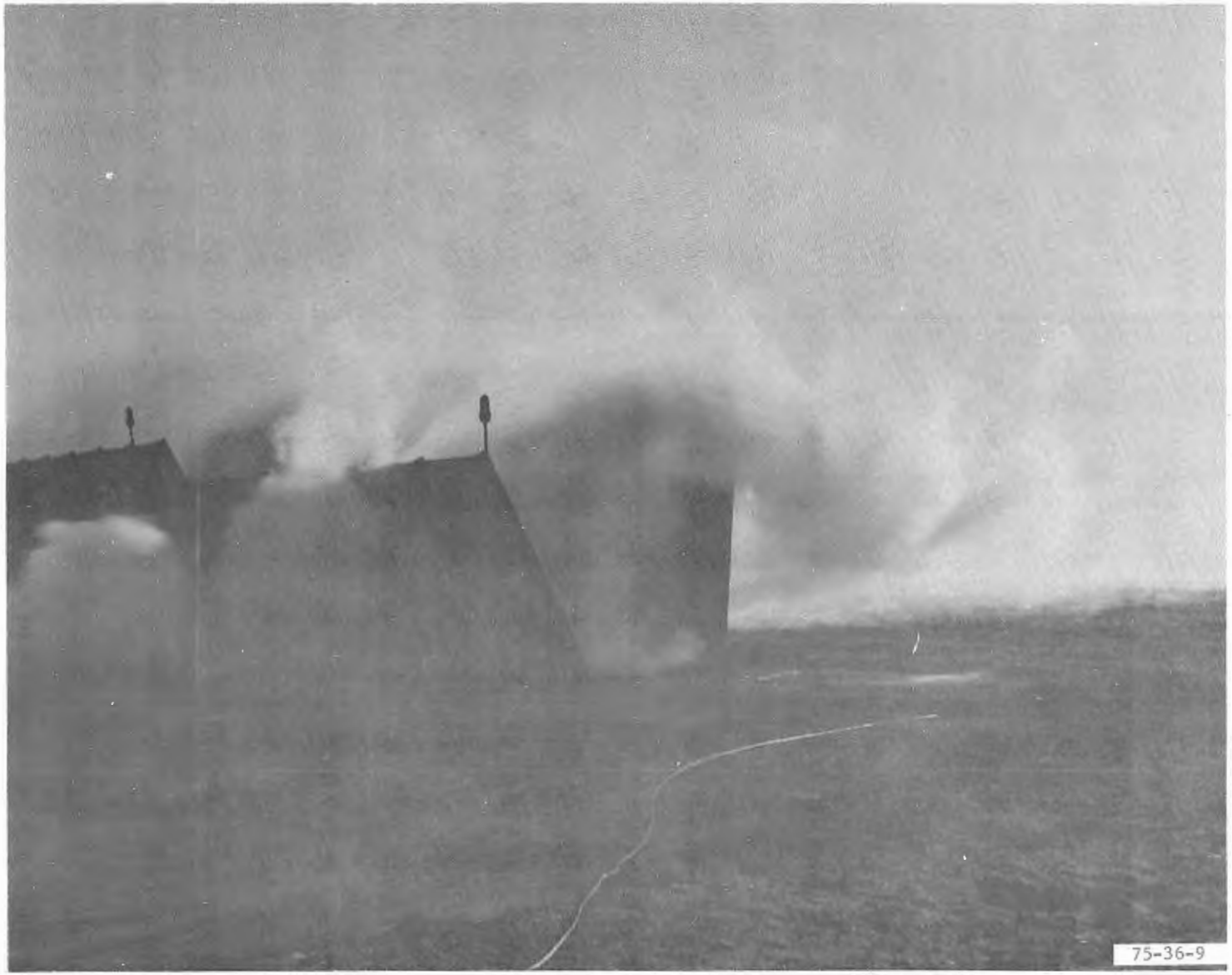

FIGURE 9. BLAST FENCE TIP VORTEX

FIGURE 10. BLAST FENCE MODIFICATION

DAY - 4 RUN # - 33 A/C TYPE - DC 1Ø
DISTANCE TAIL TO SENSOR LINE - 7ØØ FEET
SENSOR HEIGHT (FEET), LO - 1Ø HI - 4Ø
START TIME - 1Ø 14 1Ø
WIND DIRECTION - 32Ø DEG. VELOCITY - 2Ø MPH

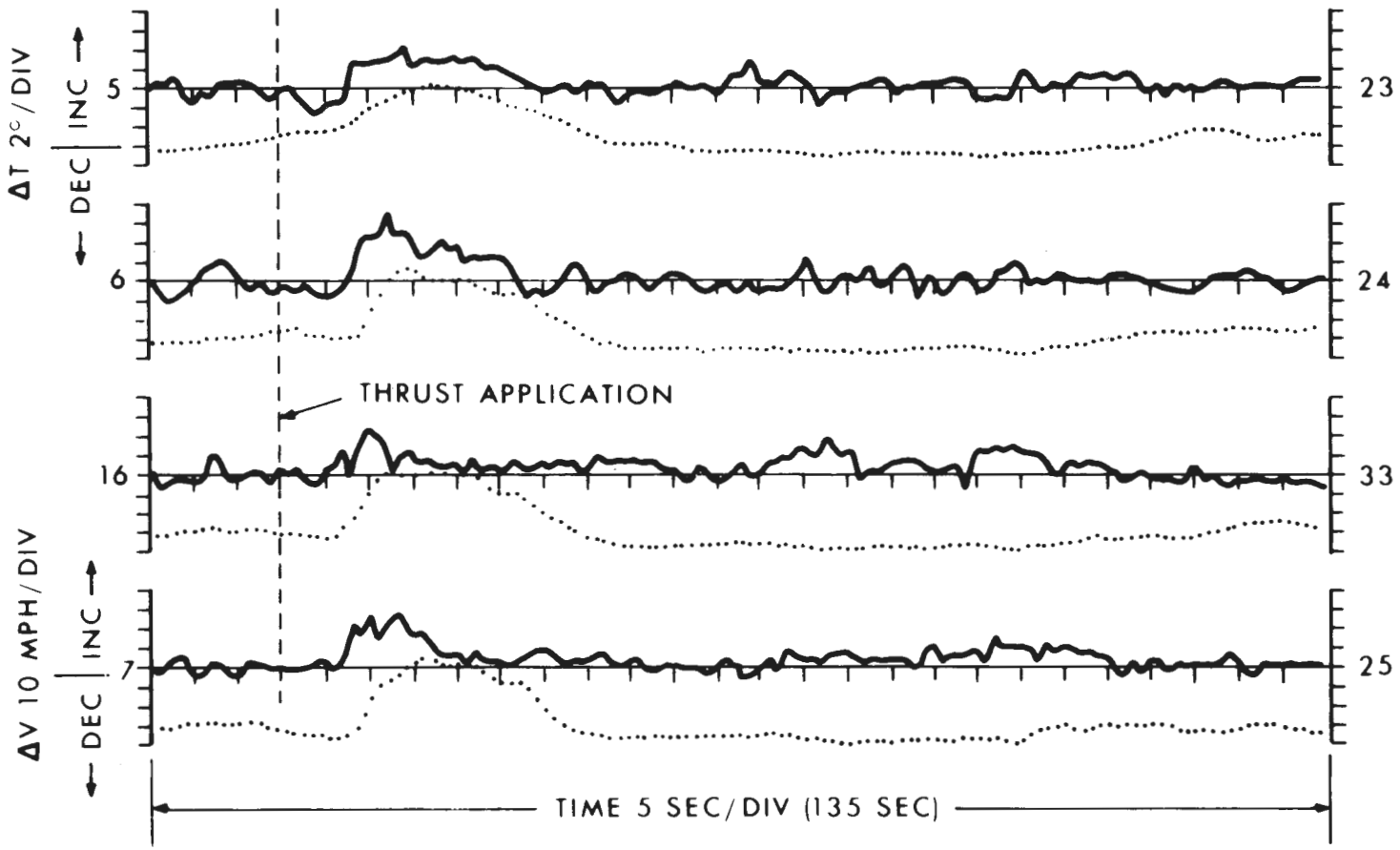

FIGURE 11. TYPICAL DATA OUTPUT 75-36-11

APPENDIX

JET BLAST TEST DATA

TABLE A-1. JET BLAST VELOCITY-TIME DATA, DC10

Run No.	D	V_m	t	T
8	195	35	33	8
11	310	20	23	6
13	160	32	35	8
27	200	30	26	7
31	290	31	32	6
33	250	34	20	7
43	270	28	20	6
59	550	—— NO	EFFECT	——
62	370	13	30	4
64	255	25	45	6
78	265	20	31	5
80	250	22	32	7
99	300	25	43	6
104	260	20	63	6
114	240	20	43	6
126	265	33	52	6
130	200	25	32	6
131	210	20	26	6
144	355	15	44	4

TABLE A-2. JET BLAST VELOCITY-TIME DATA, L1011

Run No.	D	V_m	t	T
1	-	28	55	6
19	180	25	43	6
22	-	18	45	6
24	165	—— NO	EFFECT ——	
39	220	28	22	6
48	120	29	34	8
54	200	—— NO	EFFECT ——	
72	200	19	39	6
93	200	16	30	5
105	175	20	63	6
107	220	22	40	5
121	100	25	26	4
137	245	16	40	4

TABLE A-3. JET BLAST VELOCITY-TIME DATA, B747

Run No.	D	V_m	t	T
3	230	23	25	6
15	095	21	25	6
32	280	26	35	6
34	085	23	53	8
44	190	20	38	5
45	325	32	30	6
56	355	15	17	3
66	310	—— NO	EFFECT ——	
67	155	22	46	6
75	430	17	27	7
81	285	20	28	7
90	220	20	31	6
94	255	21	31	6
116	230	22	38	7
124	335	22	28	6
132	190	15	36	6
138	130	20	26	6
139	380	14	33	4

TABLE A-4. JET BLAST VELOCITY-TIME DATA, B727

Run No.	D	V_m	t	T
4	220	17	21	5
7	285	28	20	4
12	115	20	17	5
26	330	18	18	6
28	155	16	16	6
37	310	19	28	5
47	240	20	21	6
51	270	12	24	2
55	100	—— NO	EFFECT ——	
63	600	—— NO	EFFECT ——	
76	140	12	15	4
79	205	18	21	8
91	350	10	26	3
98	170	18	33	7
106	175	17	26	6
113	210	—— NO	EFFECT ——	
117	320	10	43	5
119	090	18	20	6
127	300	18	25	7
134	530	10	9	4

TABLE A-5. JET BLAST VELOCITY-TIME DATA, B707

Run No.	D	V_m	t	T
10	255	14	37	3
23	230	—— NO	EFFECT	——
30	220	—— NO	EFFECT	——
36	125	20	29	5
41	320	—— NO	EFFECT	——
52	125	—— NO	EFFECT	——
53	400	—— NO	EFFECT	——
65	260	10	21	4
71	130	15	26	6
82	255	20	43	4
89	400	8	32	4
92	200	18	35	6
96	330	13	28	3
100	295	12	39	6
101	160	19	38	10
122	090	15	22	6
129	260	10	22	9
133	240	13	23	5
141	370	10	32	3

TABLE A-6. JET BLAST VELOCITY-TIME DATA, DC8

Run No.	D	V_m	t	T
17	210	13	36	6
35	450	13	25	6
46	270	16	35	5
61	260	8	37	4
69	160	7	39	3
85	170	18	31	7
86	550	—— NO	EFFECT	——
87	340	9	35	6
102	135	18	21	6
109	450	10	60	6
111	110	11	17	8
112	700	—— NO	EFFECT	——
125	075	20	40	7
136	260	10	26	4
142	450	—— NO	EFFECT	——
143	450	10	30	3

TABLE A-7. JET BLAST VELOCITY-TIME DATA, DC9

Run No.	D	V_m	t	T
2	235	16	16	3
9	180	——— NO	EFFECT ———	
25	270	——— NO	EFFECT ———	
29	170	15	11	3
40	250	——— NO	EFFECT ———	
42	320	——— NO	EFFECT ———	
49	290	——— NO	EFFECT ———	
57	320	——— NO	EFFECT ———	
58	350	——— NO	EFFECT ———	
60	330	——— NO	EFFECT ———	
74	380	10	22	3
84	190	——— NO	EFFECT ———	
88	700	——— NO	EFFECT ———	
97	200	10	13	3
110	325	6	19	3
115	240	——— NO	EFFECT ———	
118	460	——— NO	EFFECT ———	
123	040	10	17	3
128	170	10	15	4
140	250	8	13	2
145	375	——— NO	EFFECT ———	