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VIBRATION RESPONSES OF TEST STRUCTURE NO. 1 DURING THE EDWARDS AIR FORCE BASE PHASE OF THE NATIONAL SONIC BOOM PROGRAM

by

Donald S. Findley, Vera Huckel, and Herbert R. Henderson

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16. Abstract

In order to evaluate reaction of people to sonic booms of varying overpressures and time durations, a series of closely controlled and systematic flight test studies were conducted by the USAF in the vicinity of Edwards AFB, California, from June 3 to June 23, 1966. The NASA measured the dynamic responses of several building structures as a part of these studies. The purpose of this paper is to present in brief summary form the measurements made in a one-story residence structure (Edwards test Structure No. 1).

The report contains sample acceleration and strain recordings from F-104, B-58, and XB-70 sonic-boom exposures, along with tabulations of the maximum acceleration and strain values measured for each one of about 140 flight tests. These data are compared with similar measurements for engine noise exposures of the building during simulated landing approaches and takeoffs of KC-135 aircraft.

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VIBRATION RESPONSES OF TEST STRUCTURE NO. 1 DURING THE EDWARDS AIR FORCE BASE PHASE OF THE NATIONAL SONIC BOOM PROGRAM

By Donald S. Findley, Vera Huckel, and Herbert R. Henderson

INTRODUCTION

In order to evaluate reaction of people to sonic booms of varying overpressures and time durations, a series of closely controlled and systematic flight test studies were conducted by the USAF in the vicinity of Edwards, California, from June 3 to June 23, 1966. As a part of these studies and in direct support of them, the NASA has measured the dynamic responses of several building structures. The purpose of this paper is to present in brief summary form the measurements made in a one-story residence structure (Edwards test structure No. 1). Similar data for a two-story residence structure are included in reference 1.

Included herein are sample acceleration and strain recordings from F-104, B-58, and XB-70 sonic-boom exposures, along with tabulations of the maximum acceleration and strain values measured for each one of about 140 flight tests. These data are compared with similar measurements for engine noise exposures of the building during simulated landing approaches and takeoffs of KC-135 aircraft.

APPARATUS AND METHODS

Test Conditions

Tests described herein were accomplished in an area near the main base complex of Edwards Air Force Base, California, (See fig. 1.) from June 3 through June 23, 1966. The area has an elevation of about 2,300 feet above sea level, has sparse vegetation, and is essentially flat (See the photograph of fig. 2.).

Flights were made generally from the east (See fig. 1.) in such a way that the sonic boom waves encountered no other obstructions in the vicinity of the test structures. The sketch of figure 3 shows a planview of the structures and a microphone array used to measure the sonic boom and noise exposures.

The bulk of the tests were performed in the mornings to take advantage of the generally calm wind and atmospheric conditions prevailing at that time of day.

Test Aircraft

The four aircraft indicated in figure 5 were used during the tests. Aircraft (a) is an F-104 having a length of 54.5 feet and a maximum gross weight of 22,700 pounds. Aircraft (b) is a B-58 having a length of 96.8 feet and a maximum gross weight of 160,000 pounds. Test aircraft (c), an XB-70, is 185 feet long and has a maximum gross weight of 525,000 pounds. Aircraft (d) is a KC-135 having a length of 134.5 feet and a gross weight of 275,000 pounds. All aircraft were maintained and operated by the Air Force. The actual operating conditions for each of these aircraft for the tests reported herein are listed in Tables II through V.

Aircraft Positioning

The supersonic aircraft were for all but one flight on either a 245° or a 233° heading directly over the test area or on a parallel track five miles north of the test area as shown in figure 1. The aircraft were at all times under ground control and were being tracked by radar. Data on the heading, altitude, Mach number, and lateral displacement from the test area as listed in Tables II through V, were obtained from the radar plots. The KC-135 flew on approximately a 40° heading for all flights with altitude varying from 2,500 to 14,300 ft. with reference to mean sea level.

Weather Observations

Rawinsonde soundings were made during the time the flight tests were being carried on each day. They were made from the Edwards weather station, the location of which is indicated in figure 1. Soundings involved measurements of pressure, temperature, humidity, wind velocity, and wind direction every 1,000 feet. Such measurements were taken up to altitudes at least 5,000 feet above flight altitudes.

Surface conditions in the test area were such that temperatures varied from 57° to 97°, and the relative humdiity varied from 10 percent to 44 percent. For the bulk of the data included, surface wind velocity was too low to be an important factor.

Test Structures

Two precut residence type test structures of ordinary frame construction were erected by an Air Force contractor in an area that contained about ten other residences as shown in figure 2. Test structure No. 1 was a single-story three-bedroom house while test structure No. 2 was a two-story four-bedroom house, having a floor plan as indicated schematically in figure 4. Both houses were finished inside and out, contained appropriate furnishings, and were instrumented with microphones, accelerometers, and strain gages. Data from house No. 2 are presented in reference 1 whereas data for house No. 1 are presented herein. The floor plan and instrument location plan for house No. 1 are included in figure 4 for information.

An area outside of the houses was instrumented with microphones as indicated in figure 3. A number of people were stationed in the houses and in the immediate area outside of the houses for the subjective response part of the tests. Data on the vibration responses of house No. 1 are correlated with sonic boom and noise measurements.

INSTRUMENTATION

Test structure No. 2 was instrumented with nine accelerometers, three strain gages to measure vibratory responses, and two full-range and three audio-range microphones to measure inside pressure fluctuations (See fig. 4.). Table I is included to describe in more detail the locations of the above transducers and the quantities measured. In addition, one audio-microphone and six full-range microphones were located outside the test structure to measure the acoustic and shock wave inputs respectively (See fig. 3.).

The six full-range pressure microphones were located in a cruciform array immediately to the north-east of test structure No. 2. Five of the microphones were mounted in reflection boards at ground level with the remaining microphone at the top of a 20-foot mast located at the center of the array (See fig. 3.). All data were recorded on multi-channel magnetic tape recorders. An IRIG time signal was recorded on one channel of each tape recorder for time correlation between the radar plots and all other measurements. Block diagrams of the accelerometer, strain gage, and microphone systems are included in figure 6.

Each full-range system consisted of a specially modified condenser microphone, tuning unit, dc amplifier, magnetic tape recorder, and a direct-write oscillograph for quick visual checks on the data. The systems have a frequency response which is flat within ± 2 dB from 0.1 to 10,000 Hz and a maximum sound pressure level rating of 150 dB. All microphones were calibrated each day just before the tests with a 124 dB acoustic signal applied at the microphone.

Each audio range microphone system was made up of a microphone, power supply, amplifier, tape recorder, and direct-write oscillograph. The frequency response of each of these systems is flat within ± 1 dB from about 30 to 10,000 Hz, with a maximum sound pressure level rating of 140 dB.

The accelerometers used were of the servo type and were fastened with wood screws where possible. Molly bolts were used when accelerometers were mounted on gyp board panels. The signal from each accelerometer was conditioned by a control panel before being recorded on magnetic tape. The accelerometers could measure frequencies up to 500 Hz (± 5 percent) and accelerations up to a level of 2 "g's". They were calibrated by an electrical current insertion immediately before the tests each day.

For each strain gage circuit, a semi-conductor strain gage was used followed by a conditioning network, a strain gage control panel, and a magnetic tape recorder. The strain level range of the systems was up to 400 μ in./in. over frequencies from 0 to 10 K Hz. The systems were calibrated before the tests each day by a voltage balancing method.

RESULTS AND DISCUSSION

Inputs to the Structure

One of the main objectives of the test studies was to evaluate the responses of the structure to sonic boom inputs of varying wave lengths. In order to accomplish this, controlled flight tests were performed using F-104, B-58, and XB-70 aircraft. Sample sonic boom wave forms as measured from these aircraft are illustrated in figure 7. The main differences in the sonic boom signatures from the above three aircraft were in the time durations of the waves. The F-104 aircraft produced a signature having a time duration generally less than 0.1 second. The B-58 signature had a time duration of about 0.2 second, and the XB-70 produced a time duration as long as 0.3 second. The experiments were obtained in such a way that the overpressure Δp was comparable for the various aircraft. The average Δpo, Δt, and vertical wave angle values are recorded in Tables II through IV along with the associated aircraft flight conditions and building response data.

In addition to the sonic boom inputs a series of flight tests were conducted with the KC-135 airplane in order to simulate both take-off and landing noise conditions. During these latter noise flights similar building response measurements were made for direct comparison with the sonic boom induced responses. The noise level conditions outside of the building are listed in Table V along with the KC-135 aircraft flight conditions and the associated building response data.

Building Vibration Responses

For each data flight, acceleration levels were measured at 9 points in test structure No. 1 and strain levels were measured at 3 points as indicated in the schematic diagram of figure 4 and as described in the remarks of Table I. A quantitative picture of the type of time history records obtained during the sonic boom exposure flights is given by the tracings of sample records in figures 8 and 9.

Figure 8 contains tracings of strain time histories recorded during Mission 80 RB for three different windows of house No. 1. The trace of figure 8 (b) represents a small window having a period of vibration only a fraction of that of the sonic boom wave. The traces of figures 8 (a) and 8 (c) on the other hand represent windows for which the periods are comparable to that of the sonic boom wave.

Figure 9 includes acceleration time history responses from 8 transducer locations on the building for a B-58 sonic boom exposure (See Mission 18 B.). Each of these transient signals last less than 1.0 second, but they differ widely in their detailed appearance. For instance, the time history illustrated in figure 9 (a) exhibits a nearly single frequency vibration at about 20 cps which is believed to be the first natural frequency of the main floor joists. Similar results are given in figures 9 (b) and 9 (c) for other floor locations. The tracings of figures 8 (f) and 8 (g) represent ceiling accelerations and contain some higher frequency content (100 - 200 cps) superposed on the lower framing frequencies. The tracings of figure 9 (d), 9 (e), and 9 (b) exhibit a sizeable contribution at even higher frequencies (several hundred cps) which are superposed on the lower framing or racking mode frequencies respectively.

Included in the data of Tables II, III, and IV are peak acceleration values for records such as those of figure 9. The values of the tables represent the three largest instantaneous acceleration peak values for each sonic boom run. The positive values of the table correspond to upward deflections as indicated in figure 8 and represent movements of the structure toward the accelerometer. Likewise negative values indicate downward deflections and movements of the structure away from the accelerometer.

Included in figure 10 are tracings of the acceleration responses of the bedroom east wall (Channel 111) due to excitation from sonic booms from three aircraft. The top trace was obtained for an F-104, the middle one for a B-58, and the bottom one for the XB-70. They are generally low frequency responses with higher frequencies of relatively lower amplitude superposed. One distinguishing feature of these records is the high frequency bursts at time intervals corresponding approximately to the rapid compressions of the sonic boom waves of figure 7.

Similar data are shown for Channel 111 in figure 11. These traces represent the responses of one portion of the building to sonic booms from different missions of the B-58 aircraft. Here again the high frequency bursts occur at the times of passage of the waves. It can be seen that the records are similar in their gross features but differ markedly in their small details.

The peak acceleration amplitudes as determined from traces such as those of figures 9, 10, and 11 are plotted as a function of sonic boom overpressure in figure 12. The acceleration amplitudes are either positive or negative, whichever is the largest, from Channel 111 of Table II. The sonic boom overpressure value is the average of all ground overpressures measured for that particular flight by the microphone array of figure 3 and as listed in Tables II, III, and IV.

Data are shown in figure 12 for the F-104, B-58, and XB-70 airplanes. By means of the coding the data obtained from overhead flights can be differentiated from those associated with flights displaced about 5 miles laterally. It can be seen that acceleration amplitudes vary from about 0.10 g to about 0.7 g and that despite considerable scatter there is a general trend of increased acceleration level with increased overpressure. The closed symbol data points seem to be in good agreement with the open symbol points. There is thus the suggestion that the possible differences in wave angle and rise time due to the offset distance were significant with regard to this particular measurement of building response. As noted in reference 1, the F-104 induced accelerations tend to be somewhat higher in amplitude than those of the B-58 for given overpressure values.

Although no samples of the noise induced structural responses and inside acoustic measurement traces are included herein, the maximum values have been determined from the records and are tabulated in Tables II through V. In general the same qualitative results were obtained as are illustrated in reference 1.

CONCLUDING REMARKS

Various acceleration and strain responses of a one-story residence structure were measured for sonic boom exposures from F-104, B-58, and XB-70 airplanes and for engine noises during low altitude flyovers of a KC-135 airplane. The sonic boom induced vibration responses were generally less than one second in duration and contained frequencies associated with both primary and secondary structural components. Wall acceleration amplitudes increased generally as a function of the sonic boom overpressure, and the F-104 seemed to induce the largest amplitudes for a given overpressure. In the case of several flights at the same nominal flight conditions, the response records indicate the same gross features; however, considerable variations are noted in the peak responses and in the detailed features of the records. The results included herein are very similar in general to those tabulated in NASA TM X 72704, for a two-story residence type structure in the same test area.

REFERENCE

1. Findley, Donald S.; Huckel, Vera; and Hubbard, Harvey H.: Vibration Responses of Test Structure No. 2 During the Edwards Air Force Base Phase of the National Sonic Boom Program. TM X 72704, June 1975.

TABLE I. - IDENTIFICATION, TYPE, LOCATION AND DESCRIPTION OF THE VARIOUS VIBRATION RESPONSE AND PRESSURE TRANSDUCERS FOR WHICH DATA ARE INCLUDED. (ITEM DESIGNATIONS REFER TO FIGURE 4 AND CHANNEL NUMBERS REFER TO TABLES II THROUGH IV.)

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ITEM	CHANNEL NO.	TYPE	DATE	LOCATION	DESCRIPTION
A	101	Accelerometer	6/3 - 6/23	Center of Living Room Floor	Mounted on Concrete Block Sensitive Axis Vertical
B	102	Accelerometer	6/3 - 6/23	Center of Family Room Floor	Mounted on Concrete Block Sensitive Axis Vertical
C	103	Accelerometer	6/3 - 6/23	Center of Bedroom No. 1 Floor	Mounted on Concrete Block Sensitive Axis Vertical
D	104	Accelerometer	6/3 - 6/14	Non Operational	
			6/15- 6/20	Outside Between S. and W. Arms of Cruciform Array, On Ground	Mounted on Concrete Block Sensitive Axis Vertical
			6/21- 6/23	In House No. 2, Center of Family Room Floor	Mounted on Concrete Block Sensitive Axis Vertical
E	105	Accelerometer	6/3 - 6/23	Outside, E. Wall, N.E. Corner, Roof Line	Mounted on Stud, Sensitive Axis Horizontal
F	106	Accelerometer	6/3 - 6/23	Outside, N. Wall, N.E. Corner, Roof Line	Mounted on Stud, Sensitive Axis Horizontal
G	107	Accelerometer	6/3 - 6/5	Non Operational	
			6/6 - 6/23	Outside, on Concrete Patio	Mounted on Concrete Block Sensitive Axis Horizontal
H	109	Accelerometer	6/3 - 6/23	Center of Family Room Ceiling	Mounted on Gyp Board Panel Sensitive Axis Vertical
I	110	Accelerometer	6/3 - 6/23	Center of Bedroom No. 1 Ceiling	Mounted on Gyp Board Panel Sensitive Axis Vertical
J	111	Accelerometer	6/3 - 6/23	Bedroom No. 1, Center of E. Wall	Mounted on Stud Sensitive Axis Horizontal
K	201	Audio Mike	6/3 - 6/23	Center of Living Room	Shock Suspended, Diaphragm 6 Ft. Above Floor
L	202	Audio Mike	6/3 - 6/23	Center of Family Room	Shock Suspended, Diaphragm 6 Ft. Above Floor
M	203	Audio Mike	6/3 - 6/23	Center of Bedroom No. 1	Shock Suspended, Diaphragm 6 Ft. Above Floor
N	205	Audio Mike	6/3 - 6/5	Outside, 90 Ft. From House No. 1	Mounted 3 Ft. Above Ground, Diaphragm Pointing E., No Wind Screen
			6/6 - 6/14	Outside, 100 Ft. From House No. 1	Mounted 6 Ft. Above Ground, Diaphragm Pointing N., Wind Screened
			6/15- 6/23	House No. 2, Center of Family Room	Shock Suspended, Diaphragm 6 Ft. Above Floor
O	207	Full Range Mike	6/3 - 6/7	Center of Family Room	Shock Suspended, Diaphragm 6 Ft. Above Floor Pointing Down
			6/8 - 6/23	Center of Family Room	Shock Suspended, Diaphragm 2 In. Below Ceiling, Pointed Up
P	208	Full Range Mike	6/3 - 6/7	In Attic Above Center of Family Room	Shock Suspended, Diaphragm 8 In. Above Ceiling Joist, Pointed Up
			6/8 - 6/23	In Attic Above Center of Family Room	Shock Suspended, Diaphragm 3 In. Above Ceiling Joist, Pointed Up
Q	210	Strain Gage	6/3 - 6/23	On Stationary Side of Sliding Door in Family Room	Center of Glass, Sensitive Axis Vertical
R	211	Strain Gage	6/3 - 6/23	Bedroom No. 1, On Stationary Pane of Window in East Wall	Center of Window, Sensitive Axis Vertical
S	212	Strain Gage	6/3 - 6/23	On Large Window in Garage	Center of Window, Sensitive Axis Horizontal

TABLE II. - SONIC BOOM INDUCED ACCELERATION AND STRAIN RESPONSES OF TEST STRUCTURE NO. 1 FOR A RANGE OF B-58 FLIGHT CONDITIONS.

Date	Mission No.	Altitude msl ft.	Mach No.	Lateral Dist. Naut. mi.	Mag. Hdg. deg.	Boom Time Z	Peak Amplitude																Cruciform		Vert. Wave Angle deg.
							Accelerometer Channels g's											Strain Gage μ, in./in.			Δp_I lb/ft²		Δp_0 Avg. lb/ft²	Δt Avg. sec.	
							101	102	103	104	105	106	107	109	110	111	112	210	211	212	207	208			
6-6-66	39	31,400	1.25	4.64 N	244.0	1600.0	–	–	–	Not in Use	–	–	–	–	–	–	Not in Use	–	–	–	–	–	No Boom	–	–
	70	43,100	1.60	.55 N	245.0	1653.57	.129	-.076	.106		-.098	.106	.020	-.103	.405	-.210		9.64	8.45	18.77	1.04	1.73	2.00	0.183	48.4
	40	31,400	1.48	.20 N	246.0	1618.40	.191	.147	.146		-.156	.191	.035	-.147	–	-.291		14.58	12.23	-31.42	1.41	2.25	3.44	.156	51.2
	71	44,200	1.59	5.60 N	245.2	1650.0	-.141	.077	-.146		.110	.117	.018	.099	.331	-.259		9.43	9.79	-14.11	.69	1.38	1.71	.177	52.1
	41	31,340	1.45	.17 N	[illegible]	[illegible]	–	.155	.141		-.124	.177	.024	.154	–	-.378		12.79	14.01	25.13	1.16	1.99	2.50	.152	50.4
	72	43,920	[illegible]	4.85 N	[illegible]	[illegible]	.127	.051	-.055		-.042	.062	.020	-.074	-.206	-.025		8.38	5.45	-12.50	.66	1.30	1.99	.171	60.1
	74	32,440	1.20	.72 S	[illegible]	[illegible]	–	-.100	-.168		-.160	.176	.046	-.145	.426	–		10.62	13.34	-23.72	1.25	2.12	3.16	.193	73.0
	44	43,400	1.57	5.00 N	245.0	1711.00	.138	.060	-.097		.068	.074	-.020	.078	2.0	-.330		8.38	6.01	-11.54	.58	1.21	1.70	.195	62.1
	75	31,840	1.46	0	248.0	1717.00	–	.145	.165		-.193	.194	.046	-.167	–	–		11.74	12.90	24.83	1.14	2.16	3.18	.156	56.7
	42	43,300	1.53	0	245.0	1724.4	.180	.072	-.128		.084	.065	.007	.072	-.212	-.283		8.28	6.01	-12.50	.63	1.25	1.78	.182	–
	73	31,760	1.43	.25 N	247.0	[illegible]	–	.125	.170		-.225	.225	.033	.164	–	–		12.37	14.46	26.64	1.19	1.99	2.54	.159	53.2
6-7-66	76 A	31,560	1.48	1.09 S	241.5	[illegible]	-.159	-.121	.171	Not in Use	.161	[illegible]	-.028	-.127	.114	.153	Not in Use						3.27	.163	59.1
	45 B	43,660	1.70	4.75 N	244.5	[illegible]	[illegible]	[illegible]	.162		.122	-.217	-.031	-.169	-.223	-.181							2.01	.171	53.1
	77 B	31,680	1.51	[illegible] S	244.5	[illegible]	.172	-.124	-.158		.103	-.297	.033	.162	-.361	.153							2.91	.152	53.2
	46 B	43,720	1.65	5.42 N	246.5	1640.05	-.186	-.017	.153		.259	–	.028	-.152	-.182	.181							1.63	.171	56.7
	48 A	38,700	1.31	5.23 N	245.5	1711.20	.038	.026	.029		.018	-.032	.017	.025	.029	-.035							No Boom	–	–
	79 A	31,600	1.52	.12 N	244.5	[illegible]	-.172	-.103	.127		-.088	-.170	.040	.140	-.141	.141							2.48	.169	53.0
	49 A	43,340	1.43	4.68 N	[illegible]	1778.15	-.071	-.041	-.056		[illegible]	.065	.028	.056	.094	.070							1.44	.211	72.8
	80 A	31,600	1.53	.25 N	244.5	[illegible]	.169	-.117	-.161		-.148	-.184	-.038	.130	-.261	-.138							2.72	.156	51.6
	50 A	43,340	1.43	5.00 N	245.5	1747.37	.068	-.044	.071		-.029	-.046	-.019	.051	.059	[illegible]							1.01	.196	72.8
	51 A	31,400	1.49	[illegible]	245.0	[illegible]	-.037	.054	-.015		.042	.126	.017	[illegible]	-.085	-.011							1.95	.150	53.6
6-8-66	43 A	42,380	1.62	5.24 N	245.0	[illegible]	.156	-.072	.148	Not in Use	-.041	-.053	-.014	-.169	-.147	[illegible]	Not in Use	9.94	5.62	-10.90	.64	1.44	1.70	.175	58.7
	75 A	31,200	1.44	.23 N	[illegible]	[illegible]	[illegible]	-.171	-.152		[illegible]	.037	-.072		–	.272		12.82	14.31	31.06	1.08	2.02	3.17	.156	50.0
	42 A	43,260	1.67	4.85 N	246.7	1641.50	-.203	-.094	.150		.015	-.085	.018	[illegible]	-.216	-.215		8.95	8.17	-10.90	.62	1.24	2.06	.179	59.9
	73 A	31,200	[illegible]	.10 N	245.0	1624.20	.123	-.130	-.121		-.021	.074	-.024	[illegible]	[illegible]	.247		10.90	8.86	27.25	.92	1.82	2.22	.147	53.9
	41 A	43,200	[illegible]	[illegible] N	[illegible]	1630.10	-.128	-.050	.034		[illegible]	-.081	-.021	-.220	-.242	-.207		8.01	6.81	5.80	.55	1.11	1.92	.166	59.0
	72 A	31,200	1.47	[illegible] N	[illegible]	1638.42	.196	-.121	-.159		-.161	.167	[illegible]	–	–	.385		13.14	14.48	[illegible]	1.01	1.83	2.85	.144	49.0
	57 KB	37,600	1.66	5.70 N	[illegible]	[illegible]	[illegible]	-.045	.082		[illegible]	-.021	-.017	-.097	-.076	-.106		8.98	4.09	-10.90	.58	1.24	1.76	.162	52.2
	60 KB	31,300	1.46	.14 N	[illegible]	[illegible]	-.158	-.112	-.127		.148	-.154	.060	-.348	–	.267		10.90	10.65	27.79	1.06	2.09	2.63	.161	60.4
	56 KB	43,040	1.64	5.14 N	244.0	[illegible]	-.152	-.072	.105		[illegible]	-.052	-.0075	.107	-.180	.214		8.98	4.77	-10.90	.64	1.31	2.09	.170	55.3
	87 KB	31,440	1.49	.40 N	245.4	[illegible]	-.255	-.181	-.162		-.297	-.127	[illegible]	–	–	–		13.46	11.07	34.88	1.01	1.96	3.23	.148	48.9
	55 KB	43,200	1.64	5.16 N	[illegible]	[illegible]	[illegible]	-.137	[illegible]		[illegible]	-.154	[illegible]	–	–	–		11.54	11.92	22.59	.58	1.44	2.17	.169	58.4
	86 KB	31,360	[illegible]	0	[illegible]	[illegible]	[illegible]	-.181	[illegible]		.252	.166	-.014	–	–	–		13.78	14.99	27.06	1.06	1.83	2.70	.144	48.9

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OF POOR QUALITY

TABLE II. - CONTINUED.

Date	Mission No.	Altitude msl ft.	Mach No.	Lateral Dist. Naut. mi.	Mag. Hdg. deg.	Boom Time Z	Peak Amplitude: Accelerometer channels g's 101	102	103	104	105	106	107	109	110	111	112	Strain Gage μ. in./in. 210	211	212	ΔP_I lb/ft² 207	208	Cruciform ΔP_0 Avg. lb/ft²	Cruciform Δt Avg. sec	Vert. Wave Angle deg.
6-9-66	86 SKB	31,000	1.50	.25 N	246.2	[illegible]	.250	[illegible]	[illegible]		.390	[illegible]	-.022	-.545	-	.122	Not [illegible]	15.31	18.87	34.65	1.13	1.92	4.00	.153	51.1
	55 SKB	31,720	1.69	5.17 N	244.5	[illegible]	-.111	-.041	.377		-.066	-.012	-.014	.158	-.207	.165		9.62	6.08	14.86	.53	1.22	1.60	.140	55.5
	57 SKB	31,000	1.53	.05 S	244.0	[illegible]	[illegible]	-.177	-.167		-.151	-.157	[illegible]	-.426	-	-.401		14.75	15.30	32.10	1.08	1.56	3.44	.146	49.2
	56 SKB	43,300	1.72	4.70 N	242.6	[illegible]	-.205	-.062	.140		.066	.093	.057	.218	-.218	.302		9.62	10.27	18.33	.54	1.28	2.77	.161	51.0
	80 SKB	31,000	1.53	.06 N	[illegible]	1641.40	.146	-.120	-.119		-.140	.122	-.020	.478	-	.420		10.90	11.22	29.43	.77	1.73	2.75	.140	48.0
	57 SKB	43,100	1.70	[illegible]	244.0	[illegible]	-.150	-.068	[illegible]		[illegible]	[illegible]	-.014	[illegible]	[illegible]	-.228		8.78	7.77	15.85	.47	1.15	1.74	.150	54.3
	41 SA	[illegible]	1.52	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]		.141	.177	-.173		[illegible]	5.45	11.79	[illegible]	1.26	2.26	.180	60.4
	73 SA	31,720	1.50	[illegible]	243.4	[illegible]	[illegible]	-.165	[illegible]		.077	[illegible]	[illegible]	[illegible]	-	-.334		10.70	11.11	[illegible]	1.11	1.20	3.03	.155	54.4
	42 SA	43,060	1.52	4.61 N	[illegible]	[illegible]	[illegible]	[illegible]	.112		[illegible]	[illegible]	[illegible]	-.208	-.215	[illegible]		[illegible]	[illegible]	15.85	.64	1.41	2.25	.176	63.6
	75 SA	31,680	1.55	0	246.5	[illegible]	[illegible]	-.101	[illegible]		[illegible]	[illegible]	[illegible]	.229	-	[illegible]		[illegible]	[illegible]	[illegible]	.99	1.67	3.80	.149	48.4
	43 SA	43,000	1.65	[illegible]	[illegible]	[illegible]	-.146	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	.211	-.270	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.84	.157	51.6
	42 SA	[illegible]	1.70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	.020	[illegible]	-.178	[illegible]		[illegible]	[illegible]	[illegible]	.64	[illegible]	1.78	.165	57.4
	46 SA	42,700	[illegible]	4.74	244.0	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	.018	[illegible]	-.254	.243		8.78	7.12	14.27	.59	1.09	2.16	.156	57.7
	72 SA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	-.321	[illegible]		10.55	7.12	30.72	.92	1.67	2.26	.145	50.0
6-13-66	18 A	37,740	1.64	.01 S	231.0	[illegible]	-.202	-.159	-.132		.160	-.152	-.012	[illegible]	-	.191		11.92	[illegible]	[illegible]	1.05	1.60	2.82	.160	42.2
	18 B	49,600	1.66	[illegible]	[illegible]	[illegible]	-.142	[illegible]	-.107		.049	[illegible]	-.024	[illegible]	.270	[illegible]		[illegible]	9.81	13.19	.84	1.30	2.07	.196	45.7
	21 A	37,840	1.61	.21 S	230.0	[illegible]	-.213	-.148	-.157		[illegible]	[illegible]	-.055	[illegible]	-	[illegible]		[illegible]	14.40	[illegible]	1.05	1.42	2.86	.146	44.0
	21 B	49,160	1.72	.35 S	[illegible]	[illegible]	[illegible]	.122	[illegible]		[illegible]	[illegible]	-.006	.142	.402	[illegible]		[illegible]	9.46	14.92	.82	1.30	1.88	.195	42.4
	29 A	49,300	1.67	[illegible]	[illegible]	[illegible]	-.152	-.104	[illegible]		[illegible]	[illegible]	[illegible]	.47	-	[illegible]		[illegible]	[illegible]	13.19	.79	1.30	1.87	.195	46.6
	29 B	38,140	1.67	.11 S	[illegible]	[illegible]	-.175	[illegible]	-.137		[illegible]	[illegible]	[illegible]	-.173		.74		[illegible]	10.08	[illegible]	.99	1.42	3.42	.156	45.6
	32 A	[illegible]	1.64	[illegible]	[illegible]	[illegible]	-.161	.010	-.100		[illegible]	.155	.057	.130	-.260	.131		[illegible]	6.93	[illegible]	.75	[illegible]	1.93	.182	47.3
	32 B	[illegible]	1.67	0	[illegible]	[illegible]	.196	-.124	-.123		.103	.166	[illegible]	-.170	-	[illegible]		9.82	[illegible]	[illegible]	.90	1.36	2.30	.149	43.4
6-20-66	48 A	41,300	1.55	[illegible] N	[illegible]	[illegible]	-.209	-.104	.134		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	R-11 [illegible]	[illegible]	[illegible]	[illegible]	18.09	.89	.90	2.67	.179	51.8
	79 A	32,100	1.45	[illegible]	[illegible]	[illegible]	-.117	-.102	[illegible]		[illegible]	[illegible]	[illegible]	-.205			[illegible]	[illegible]	13.85	26.16	1.21	.83	2.46	.153	54.1
	[illegible] A	42,700	1.59	[illegible]	[illegible]	[illegible]	.121	[illegible]	[illegible]		[illegible]	[illegible]	-.011	[illegible]	[illegible]		-.127	[illegible]	[illegible]	12.58	.71	.60	1.47	.175	53.7
	84 A	[illegible]	1.43		[illegible]	[illegible]	-	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	-		.401	[illegible]	17.40	22.65	1.30	1.05	2.55	.144	49.4
	74 A	[illegible]	[illegible]	4.81 N	[illegible]	[illegible]	[illegible]	.071	[illegible]		[illegible]	.016	[illegible]	.111	[illegible]		.116	8.28	6.92	12.46	.62	.68	1.47	.164	55.1
	59 B	[illegible]	[illegible]	[illegible] N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	-.144	.016	[illegible]	[illegible]		[illegible]	12.43	10.48	-11.51	1.09	.94	2.34	.218	65.7
	78 B	31,240	[illegible]	0	[illegible]	[illegible]	-.221	.153	-.152		.115	.170	-.051	[illegible]	-		.534	12.45	16.14	26.78	1.33	1.13	3.04	.154	58.5
	90 B	31,800	[illegible]	.11 S	[illegible]	[illegible]	[illegible]	.142	-.146		[illegible]	-.151	-.034	[illegible]	-		.487	13.08	13.83	28.65	1.24	1.02	2.80	.145	52.2
	85 A	[illegible]	1.45	4.35 N	231.4	[illegible]	[illegible]	-	-		-	-	-	-	-		-	13.45	9.85	23.67	.77	.87	2.39	.143	60.1
	93 B	32,140	1.55	.17 S	231.4	[illegible]	-.214	-.135	-.162		-.014	[illegible]	-.069	.214	-		-.338	12.52	13.83	30.52	1.24	1.05	2.90	.141	52.2

TABLE II. - CONCLUDED.

Date	Mission No.	Altitude msl ft.	Mach No.	Lateral Dist. Naut. mi.	Mag. Hdg. deg.	Boom Time	Peak Amplitude: Accelerometer Channels g's 101	102	103	104	105	106	107	109	110	111	112	Strain Gage μ, in./in. 210	211	212	Δp$_I$ lb/ft^2 207	208	Cruciform Δp$_0$ Avg. lb/ft^2	Cruciform Δt Avg. sec.	Vert. Wave Angle deg.
6-21-66	59 B	31,760	1.46	.12 N	232.0	1601.55	-	.142	-.155	In House #2	.212	.115	.054	.341	-	A-11 Transducer - in Channel # 112 on these days	.300	14.99	10.90	26.64	0.98	2.08	2.81	.151	49.2
	58 B	43,600	1.67	5.12 N	232.6	1611.02	.154	-.056	.111		-.062	-.059	.0495	.148	-.171		-.206	8.17	6.26	-13.32	.51	1.15	1.95	.175	55.3
	99 B	21,700	1.47	[illegible]	233.0	1617.05	[illegible]	[illegible]	-.175		.171	.169	.049	.423	-		-	16.35	18.17	-26.64	1.01	2.00	3.22	.148	57.0
	66 B	39,860	1.59	5.00 N	[illegible]	1625.17	.114	[illegible]	.070		-.028	-.024	-.020	.064	-.123		-.121	7.49	4.44	4.69	.49	.92	1.22	.167	59.0
	100 B	21,760	1.46	.14 S	231.8	1620.23	.111	.093	-.107		.103	-.122	-.021	.290	-		.243	12.60	9.69	-23.01	.88	1.77	3.03	.146	49.2
	68 B	44,080	1.62	4.[illegible] N	232.0	1629.49	[illegible]	-.027	.086		.014	-.132	-.020	.157	-.218		.160	6.81	5.85	-9.69	.47	.92	1.51	.167	54.5
	69 B	39,440	1.39	5.00 N	232.7	1721.25	[illegible]	-.075	.101		.053	.161	-.0075	-.241	-.171		.257	10.56	5.45	-13.13	.64	1.36	1.65	.186	72.0
	48 A	43,140	1.60	5.00 N	231.6	1744.12	.151	-.072	.05		-.037	-.097	-.011	.172	-.282		.223	10.22	5.65	-12.11	.69	1.31	1.51	.177	62.8
	40 A	43,840	1.65	5.40 N	[illegible]	1756.[illegible]	.14	-.061	.100		-.058	-.106	.024	.187	-.216		.227	9.20	6.06	-11.51	.54	1.15	1.88	.171	57.1
	60 B	43,740	1.64	5.16 N	232.2	1808.59	.141	[illegible]	.091		-.031	-.014	.021	.128	-.123		.160	7.53	4.04	12.11	.49	1.04	1.73	.165	58.9
	61 B	43,260	1.62	4.76 N	232.5	1937.19	.07	-.052	.052		.045	.169	.029	.084	-.085		-.185	9.54	3.83	-14.53	.59	1.35	2.49	.181	59.0
	101 B	31,700	1.50	0	232.8	1951.15	-	.106	-.141		[illegible]	.147	-.019	.344	-.388		.267	13.02	9.49	[illegible]	.91	1.92	2.67	.148	52.2
	85 A	21,700	1.50	.22 N	233.7	2005.50	-	.140	-.101		-.109	-.153	-.017	.433	-		.295	14.21	9.49	21.85	.83	1.65	2.84	.146	50.9
6-22-66	25 A	37,000	1.62	.18 N	234.5	1613.27	.157	.126	-.143		-.216	.262	-.024	-.518	1.25		-	14.11	17.82	22.75	1.01	1.76	2.66	.162	50.5
	19 A	37,200	1.64	.24 N	233.[illegible]	1628.15	[illegible]	.073	-.013		.068	-.091	-.023	.267	.433		.235	9.94	8.65	18.48	.77	1.53	2.06	.154	47.7
	6 X	42,560	1.60	1.34 S	259.0	1648.24	[illegible]	-.146	.197		-.106	.126	.010	.326	.621		-	7.69	10.03	25.59	.94	1.42	3.44	.167	50.9
	30 A	37,400	1.65	.20 S	229.8	1743.34	-.122	-.073	-.093		-.014	.102	-.019	-.237	.357		-.234	11.86	5.88	-21.33	.86	1.59	2.04	.163	47.5
	34 B	42,400	1.61	4.00 N	230.0	1757.06	-.104	.053	.061		.035	.063	.018	.163	.235		-.141	6.73	3.81	-9.48	.58	.90	1.48	.169	56.2
	24 A	43,300	1.60	5.06 N	233.0	1810.37	-.128	-.060	.072		.053	-.041	.010	.148	.179		-.164	8.66	4.50	12.32	.58	1.07	1.44	-	-
	35 A	43,400	1.60	.92 S	225.3	1821.21	[illegible]	-.043	.061		-.026	-.039	-.0055	.104	-.113		-.110	7.05	2.77	9.48	.45	.88	1.18	.165	-
	25 B	43,220	1.59	4.89 N	233.0	1837.59	.156	-.066	.136		[illegible]	.070	-.017	.222	-.207		-.237	8.01	5.36	10.43	.55	1.08	1.42	.179	56.4
	23 B	37,440	1.63	.50 N	[illegible]	1852.05	.156	-.076	-.118		.016	-.069	-.017	.281	-.433		.239	11.22	7.96	18.96	.79	1.50	2.21	.157	48.0
6-23-66	17 A	37,600	1.64	.31 N	231.5	1546.66	-.165	-.100	-.111		[illegible]	.219	-.026	-.370	.461		.240	10.10	10.55	27.25	.78	1.62	2.40	.162	46.1
	22 B	43,360	1.67	4.25 N	229.2	1600.40	-.162	-.086	.397		.044	.067	.0052	.420	.273		-.184	8.52	6.86	14.99	.52	1.13	1.63	.168	52.8
	31 A	37,480	1.64	.12 N	231.0	1612.14	-.155	-.093	-.108		-.085	.080	.015	.370	-.517		[illegible]	10.56	10.55	23.84	.74	1.43	1.98	.155	47.3
	33 A	43,200	1.64	5.02 N	231.6	1621.38	-.137	-.070	.086		-.044	-.057	-.0055	.168	-.100		.149	8.86	5.45	14.99	.43	1.02	1.25	.163	59.0
	20 B	37,400	1.55	.10 N	[illegible]	1954.17	-.229	-.153	-.136		[illegible]	[illegible]	-.035	.537	-.700		-	11.55	11.95	25.89	.83	1.66	2.09	.159	47.7
	36 B	37,400	1.66	.25 S	[illegible]	2006.26	-.243	-.126	.176		-.14	-.159	-.077	-.376	-.555		-	[illegible]	8.26	32.70	.97	1.81	5.50	.160	49.4
	6X-2	[illegible]	1.67	[illegible] N	258.0	2021.21	[illegible]	-.080	[illegible]		-.044	-.082	-.025	-.202	-.216		-	8.86	5.21	23.16	.57	1.43	1.79	.168	-

ORIGINAL PAGE IS OF POOR QUALITY

TABLE III. - SONIC BOOM INDUCED ACCELERATION AND STRAIN RESPONSES OF TEST STRUCTURE NO. 1 FOR A RANGE OF F-104 FLIGHT CONDITIONS.

Date	Mission No.		Altitude msl ft.	Mach No.	Lateral Dist. Naut.mi.	Mag. Hdg. deg.	Boom Time	Peak Amplitude Accelerometer Channels g's											Strain Gage μ, in./in.			Δp_I lb/ft^2		Cruciform Δp_0 Avg. lb/ft^2	Cruciform Δt Avg. sec.	Vert. Wave Angle deg.
								101	102	103	104	105	106	107	109	110	111	112	210	211	212	207	208			
6-4-66	14		35,600	1.7	-	-		-.170	[illegible]	.101		[illegible]	-.027	-	-	-	-		7.63	6.00	-6.61	.38	.81	1.19	.087	-
6-13-66	26	A	21,200	1.4	.08 N	222.5	1712.35	-.192	.124	-		.11	-.110	-.045	[illegible]		-.159		9.88	8.23	9.18	.45	.83	1.87	.074	50.8
	26	B	29,660	1.6	[illegible]	-	1713.45	-	-	-		-	-	-	-		-		-	-	-	-	-	-	-	-
6-14-66	26	A	-	-	-	-	1605.0	-.155	-.156	-.120		.293	.074	.018	.452	.297	-.306	Channel 112 interchanged with channel 111	6.81	10.28	-12.11	.54	.97	2.08	.072	-
	26	B	29,920	1.54	.10 S	[illegible]	1610.50	-.145	-.061	-.110		-.027	-.087	.013	.112	.021	-.254		9.54	7.21	-12.73	.47	.72	1.56	.079	46.6
	38	A	-	-	-	-	1745.00	-.118	.125	-.120		.074	-.156	.022	.458	.222	-.202		11.58	7.40	11.51	.44	.84	2.02	.074	-
	38	B	21,700	1.52	0	222.6	1745.45	-.118	.070	-.083		-.041	-.045	.017	-	-	-		8.56	4.52	10.29	.44	.66	1.52	.079	49.4
	37	A	29,700	1.49	0	231.2	1757.30	-.162	.106	-.093		-.053	-.079	.023	.264	.225	-.306		9.54	5.76	-9.69	.38	.78	1.39	.019	48.7
	37	B	21,080	1.31	.02 S	231.0	1758.40	-.241	.171	-.119		-	-.188	.035	.584	.406	-.383		11.58	10.28	11.51	.49	1.21	2.77	.015	53.2
6-15-66	1X	A	14,080	1.21	.47 N	236.0	1614.50	-.218	.210	.207	-.0211	.183	.171	-.052	-.617	-	-.557		16.17	15.84	15.14	.59	1.26	3.75	.079	62.1
	1X	B	28,140	1.50	.13 N	233.0	1616.40	-.108	.079	-.073	-.0108	-.054	-.089	-.039	-.206	-.306	.192		-7.27	5.96	8.48	.40	.53	1.51	.079	48.1
	2X	A	29,700	1.32	.66 N	237.0	1621.40	.194	-.111	-.123	-.0076	-.078	.071	.0097	-.270	.294	.250		-7.60	6.58	-10.90	.50	.82	1.74	.092	63.5
	2X	B	14,080	1.20	.22 N	233.0	1622.10	-	-.246	.264	.0210	.157	-.151	-.043	.505	-	.615		22.15	18.51	18.77	.69	1.56	4.36	.079	62.0
	3X	A	29,100	1.58	.17 N	234.0	1638.25	-.092	.065	-.059	-.0045	-.024	.081	-.012	.206	.259	.192		-5.95	3.91	-6.06	.32	.47	1.31	.075	51.5
	3X	B	14,200	1.15	.18 N	235.0	1639.55	-.223	.125	.120	-.0200	-.054	-.154	-.031	.421	-	.404		13.01	9.67	12.93	.57	1.03	2.25	.077	63.4
	4X	A	14,060	1.28	.18 N	235.0	1647.15	-.218	-.159	.159	-.0113	.202	.170	-.060	.603	-	.557		15.12	12.78	12.72	.55	1.17	3.36	.067	55.0
	4X	B	29,880	1.62	.44 S	233.5	1648.20	-.190	-.151	-.132	-.0018	-.085	-.080	-.019	-.402	-	-.375		14.42	9.05	14.53	.48	.82	2.58	.077	45.6
6-16-66	27	A	29,300	1.65	.10 S	230.3	1556.25	-.147	.113	.118	-.0154	-.096	-.115	-.024	.356	-	-.134		8.17	8.23	-9.69	.34	.61	1.51	.075	43.1
	27	B	20,540	1.40	.26 S	228.5	1557.50	-.156	-.092	.100	-.0154	.105	.113	-.029	.288	-.245	-.134		-7.83	9.46	-10.90	.40	.76	1.73	.073	51.1
	5X		29,700	1.65	.25 E	344.0	1604.25	-.107	.124	-.173	-.0166	-.045	-.075	.0055	-.591	-	129		-4.43	-5.25	-18.17	.38	.73	1.78	.071	41.8
6-22-66	28	B	20,820	1.35	.16 S	233.0	1612.43	-.233	.166	-.158	In House #2	.197	-.241	-.053	.563	-.903		-	11.86	13.15	-18.48	.58	1.25	2.60	.078	50.1
	19	B	29,500	1.42	.20 S	233.5	1620.05	.181	.140	.104		-.121	.100	.071	.252	-.433		-.201	10.26	-7.47	18.01	.48	.71	1.87	.088	52.8
	30	B	29,720	1.37	.16 S	232.5	1744.38	.056	.327	-.043		.038	-.043	.0092	.133	.160		-.107	-5.77	3.11	-10.90	.38	.60	.97	.092	62.0
	34	B	29,600*	1.31	-	232.8	1757.06	.147	.080	.082		-.065	-.056	.015	.296	.320		209	-7.05	-4.63	12.80	.38	.65	1.14	.094	-

* Alt. ; Mach to .4 12 [illegible] mi. E

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TABLE III. - CONCLUDED.

Date	Mission No.		Altitude msl ft.	Mach No.	Lateral Dist. Naut. mi.	Mag. Hdg. deg.	Boom Time Z	Peak Amplitude: Accelerometer Channels g's 101	102	103	104	105	106	107	109	110	111	112	Strain Gage μ, in./in. 210	211	212	Δp		Cruciform		Vert. Wave Angle deg.
																						Δp_I lb/ft^2 207	208	Δp_0 Avg. lb/ft^2	Δt Avg. sec.	
6-22-66	24	B	20,860	1.36	.22 S	231.3	1811.26	.167	.136	-.115		-.159	-.158	-.059	.533	-.696		.242	9.62	10.21	-16.11	.46	.99	2.10	.078	55.0
	25	B	21,060	1.28	.25 N	225.8	1822.47	-.201	.153	.133		-.117	-.145	-.028	.341	-.564		.235	-9.62	6.57	-14.22	.43	.92	2.41	.082	59.5
	25	A	21,900	1.34	.21 N	[illegible]	1836.39	-.111	.140	-.104		-.163	-.137	.015	.489	-.527		-	-9.30	7.44	-11.37	.43	.86	1.47	.075	54.4
	23	A	29,720	1.51	.34 N	237.0	1850.21	.113	.096	-.079		-.045	-.065	-.020	-.193	-.263		-.151	-7.69	4.84	-10.90	.53	.71	1.43	.083	—
6-23-66	17	B	21,600	1.40	.46 S	227.5	1548.00	-.162	.103	.100		-.063	-.059	-.017	.302	-.339		-.232	10.22	7.63	-11.30	.45	.79	1.88	.076	49.3
	22	A	29,260	1.40	0	232.0	1559.51	-.151	.056	.090		[illegible]	-.087	-.012	.225	-.395		.188	-8.17	-6.98	-9.69	.45	.75	1.61	.082	51.4
	21	B	21,260	1.39	0	232.0	1612.11	-.172	.096	.104		-.077	.059	-.014	.226	-.488		-.231	10.90	8.44	-8.88	.43	.79	2.18	.076	49.6
	33	B	29,840	1.49	.10 S	229.8	1622.04	.281	.153	-.122		-.114	-.109	-.035	.554	-1.02		—	13.62	9.84	18.39	.45	.90	1.82	.084	49.7
	20	A	21,520	1.37	.19 N	232.2	1951.20	-.253	.173	.129		-.121	-.163	.016	-.454	.687		—	14.31	7.91	18.39	.48	.98	1.88	.079	55.2
	26	A	20,860	1.39	.31 S	230.2	2005.15	-.232	.179	-.125		-.126	-.132	-.024	.638	-.524		—	10.40	7.56	14.91	.45	.98	2.09	.077	53.3
	7	X	29,640	1.55	.21 S	271.6	2018.17	-.141	-.103	.125		.074	.083	.014	-.252	.339		—	-7.57	5.63	32.70	.59	.98	2.03	.081	—

TABLE IV. - SONIC BOOM INDUCED ACCELERATION AND STRAIN RESPONSES OF TEST STRUCTURE NO. 1 FOR A RANGE OF XB-70 FLIGHT CONDITIONS.

Date	Mission No.	Altitude msl ft.	Mach No.	Lateral Dist. Naut mi	Mag. Hdg. deg.	Boom Time Z	Peak Amplitude: Accelerometer Channels g's 101	102	103	104	105	106	107	109	110	111	112	Strain Gage μ, in./in. 210	211	212	Δp_I lb/ft^2 207	208	Cruciform Δp_0 Avg. lb/ft^2	Cruciform Δt Avg. sec.	Vert. Wave Angle deg.
6-4-66	13	52,920	1.81	2.5 N	243.0	1728.00	-.256	-.117	.100		-.127	.174		--	-	-		15.26	11.58	-9.25	1.33	2.75	2.52	.250	42.8
6-6-66	22	72,[illegible]	2.[illegible]	4.10 N	262.0	1726.[illegible]	-.127	.094	.101		.072	-.088	.013	.137	-.362	-.193		7.97	4.78	15.75	1.05	1.30	1.64	.3175	-
6-8-66	1	31,860	1.38	5.02 S	246.0	1519.00	.151	-.049	-.127		[illegible]	.034	-.014	-.128	-.102	.194		11.54	5.11	-14.71	.19	1.83	2.27	.233	61.8

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TABLE V. - ENGINE NOISE INDUCED ACCELERATION AND STRAIN RESPONSES OF TEST STRUCTURE NO. 1 FOR A RANGE OF KC-135 FLIGHT CONDITIONS.

Date	Mission No.	Altitude msl	EPR	Velocity	Maximum Peak Amplitude													Noise Levels, dB			
					Accelerometer Channels g's										Strain Gage μ, in./in.			RMS Out-side	Peak Inside		
		ft.		Kts.	101	102	103	104	105	106	107	109	110	111	210	211	212	205	201	202	203
6-6-66	39 B	10,300	1.6	310	-	-	-	Not in Use	-	-	-	-	-	-	-	-	-	-	-	-	-
	70 B	5,400	1.5	260	.004	.003	.009		.009	.007	.006	.006	.016	.012	.423	.266	0	84.8	114.6	115.1	128.6
	40 B	5,400	1.5	280	.004	.005	.007		.010	.008	.006	.006	.013	.020	.423	.266	0	84.5	114.6	115.1	114.1
	71 B	3,300	1.5	290	.009	.007	.008		.015	.032	.008	.012	.042	.025	.529	.532	0	102.9	120.6	122.5	123.7
	41 B	3,300	1.5	238	.009	.037	.006		.018	.037	.008	.011	.050	.022	.423	.372	0	101.1	121.6	120.6	117.7
	72 B	2,800	1.5	290	.009	.009	.009		.028	.048	.010	.020	.083	.046	.635	.744	0	108.9	125.5	127.6	129.4
	43 B	14,300	2.35	325	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-
	74 B	8,300	2.35	328	.007	.005	.006		.008	.007	.007	.007	.011	.018	.423	.319	0	105.7	127.6	121.6	119.0
	44 B	8,300	2.35	330	.011	.009	.009		.051	.085	.018	.030	.165	.087	.529	2.12	.779	111.1	128.6	130.4	133.0
	75 B	3,300	2.35	213	.030	.022	.024		.295	-	.052	.135	-	-	1.06	5.95	1.09	-	139.8	140.6	143.5
	42 B	2,800	2.35	213	.064	.049	.054		-	-	.132	-	-	-	.847	-	1.09	-	-	-	-
	73 B	2,520	2.35	213	.016	.005	.009		.032	.048	.011	.021	.083	.042	.529	1.06	.779	106.9	124.1	127.6	130.4
6-7-66	76 B	4,360	2.35	190	.009	.011	.011		.084	.071	.041	.096	.110	.117				106.9			
	45 A	3,000	2.35	195	.026	.028	.024		-	-	-	.233	.311	.171				114.8			
	77 A	3,000	2.35	190	.027	.022	.024		.143	.142	.036	.216	.317	.202				115.1			
	46 A	2,620	2.35	190	.019	.018	.022		.045	.070	.025	.155	.343	.155				116.2			
	48 B	3,000	2.35	205	.025	.031	.029		.100	.117	.028	.156	.270	.322				114.8			
	79 B	2,620	2.35	195	.099	.059	.058		.311	.239	.064	.432	.716	.477				-			
	49 B	4,300	2.25	195	.009	.010	.009		.002	.051	.024	.070	.111	.091				110.4			
	80 B	2,000	2.35	190	.044	.041	.032		.116	.091	.063	.161	.285	.236				115.6			
	50 B	8,300	2.35	200	.007	.006	.007		.014	.012	.004	.014	.026	.014				-			
	81 B	4,300	2.35	195	.013	.013	.010		.046	.040	.014	.068	.101	.081				106.2			
6-8-66	43 B	14,300	2.35	182	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-
	75 B	8,300	2.35	168	.0093	.0045	.011		.014	.0075	.0072	.023	.020	.018	.641	.511	1.09	101.0	115.0	116.5	118.0
	42 B	2,800	1.5	160	.014	.011	.011		.033	.033	.011	.079	.120	.063	.962	2.38	1.63	108.5	120.1	120.9	124.6
	73 B	2,552	1.5	175	.021	.027	.020		.068	.081	.019	.212	.357	.166	1.28	5.11	1.63	114.6	126.1	127.7	131.2
	41 B	5,300	1.5	157	.012	.0045	.014		.0070	.0071	.0072	.013	.021	.018	.641	.511	1.09	97.7	116.5	114.9	118.0
	72 B	2,800	1.5	174	.014	.011	.0091		.026	.042	.011	.074	.120	.060	.962	1.70	1.09	107.8	120.1	119.0	123.3
	57 RA	3,300	1.5	166	.012	.011	.023		.014	.018	.0072	.033	.045	.033	.641	1.19	1.63	100.4	117.9	119.0	118.0
	80 RA	2,800	1.5	169	.026	.011	.011		.031	.040	.013	.072	.099	.058	.641	1.53	1.63	106.7	120.1	119.0	123.3
	56 RA	5,300	1.5	155	.0093	.012	.0091		.0070	.0083	.0060	.018	.024	.010	.641	.511	1.09	97.7	113.0	116.5	116.6
	87 RA	3,300	1.5	166	.0093	.034	.011		.016	.024	.0072	.044	.057	.028	.962	1.19	1.63	102.9	117.9	121.7	119.1
	55 RA	10,300	1.5	146	.0070	.0090	.0091		.012	.011	.0084	.028	.045	.025	.962	.341	1.09	92.5	113.0	114.9	119.1
	86 RA	5,300	1.5	176	.0070	.0067	.011		.0070	.0071	.0060	.013	.018	.013	.641	.681	1.63	96.9	115.0	116.5	127.1

TABLE V. - CONCLUDED.

Date	Mission No.	Altitude msl ft.	EPR	Velocity Kts.	Maximum Peak Amplitude													Noise Levels, dB			
					Accelerometer Channels g's										Strain Gage μ, in./in.			RMS Outside	Peak Inside		
					101	102	103	104	105	106	107	109	110	111	210	211	212	205	201	202	203
6-9-66	86 SA	5,300	1.5	111	0	.0078	0		.022	.045	0	.030	.024	.016	.962	.524	1.56	94.1	130.8	130.5	127.4
	55 SA	10,200	1.5	225	0	.0052	0		.011	[illegible]	0	.023	.012	0	.962	.524	1.56	94.1	130.8	126.9	131.0
	87 SA	2,300	1.5	190	.010	.0078	.011		.0074	.025	0	.023	.060	.016	.801	.838	1.30	92.8	132.1	130.5	131.0
	56 SA	5,300	1.5	173	.0669	.0052	.025		0	.0090	0	.022	.027	.024	.801	.734	1.30	100.1	127.3	126.9	143.0
	80 SA	2,800	1.5	173	.014	.013	.014		.033	.040	.014	.068	.135	.073	.801	1.26	1.30	95.8	130.8	134.9	133.4
	57 SA	2,300	1.5	170	.010	.0078	.011		.015	.029	0	.020	.042	.024	.801	.838	1.56	96.3	127.3	130.5	131.0
	72 SB	2,800	1.5	172	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	41 SB	5,200	1.5	152	.0069	.0052	.014		0	.0090	0	.023	.018	.016	.641	.629	1.04	92.8	127.3	137.8	127.4
	73 SB	2,550	1.5	178	.062	.026	.015		.074	.126	.020	.152	.213	.162	.962	1.15	1.82	103.2	133.3	137.8	135.4
	42 SB	2,800	1.5	158	.014	.013	.011		.044	.126	.013	.083	.156	.065	.962	2.41	1.82	105.2	133.3	134.9	137.0
	75 SB	8,300	2.35	162	.010	.0078	.011		0	.013	0	.030	.027	.024	.641	.524	1.56	96.3	129.2	126.9	133.4
	43 SB	14,300	2.35	135	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–
	42 SB	2,800	1.5	162	.014	.013	.011		.040	.065	.011	.083	.135	.065	.801	1.15	1.56	99.5	130.8	134.9	133.4
	46 SB	3,300	2.35	172	.024	.018	.021		.261	.301	.069	.288	–	.349	1.12	8.07	1.82	117.8	142.8	144.4	147.8
	72 SB	2,800	1.5	164	.021	.034	.011		.033	.065	.0054	.068	.099	.049	.641	1.89	1.56	102.8	133.3	139.0	137.0
														ch. 112				Ch. 204			
6-20-66	48 B	5,280	1.5	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–
	79 B	3,300	1.5	190	.0083	.0089	.0080		.014	.033	.0048	.039	.053	.033	.545	.943	.934	100.9	122.7	125.3	126.3
	53 B	4,300	2.35	200	.014	.019	.011		.056	.084	.026	.096	.145	.099	.545	2.20	1.25	112.2	128.0	131.8	134.9
	84 B	2,000	2.30	195	.033	.069	.022		.174	–	.041	.221	.233	.231	1.090	5.55	1.56	119.1	136.7	140.0	144.0
	54 B	3,000	2.30	195	.024	.043	.022		.163	–	.034	.234	.239	.262	.812	6.08	1.71	119.7	135.8	139.9	142.4
	59 A	12,000	2.35	180	.0070	.0066	.0091		–	.0047	–	.017	.132	.020	0	0	.934	94.3	119.2	121.8	118.4
	98 A	6,000	2.35	200	.012	.086	.017		.016	.024	.0039	.037	.065	.041	0	.943	.934	107.3	124.0	126.3	132.3
	60 A	6,000	2.25	175	.0083	.010	.014		.021	.034	.0090	.044	.075	.048	.545	1.15	1.090	106.9	126.2	126.2	129.2
	90 A	6,000	2.35	175	.019	.010	.061		.042	.047	.0087	.054	.094	.063	.654	2.10	1.090	106.6	128.7	130.8	134.3
	85 B	2,600	2.30	185	.080	.054	.064		–	–	–	–	–	–	1.96	14.36	2.49	–	146.6	147.9	149.4
	93 A	2,600	2.30	195	.068	.049	.052		–	–	–	–	–	–	2.18	13.42	2.49	–	146.6	147.7	149.5
6-21-66	89 A	2,500	1.5	220	.028	.032	.027		.120	.118	.041	.158	.182	.115	.826	2.22	1.51	118.9	133.3	132.7	136.1
	58 A	2,800	1.5	205	.016	.012	.011		.026	.061	.0095	.075	.108	.053	.826	1.61	1.51	108.3	126.1	127.4	129.2
	99 A	4,200	2.35	194	.015	.010	.014		.049	.082	.025	.098	.150	.106	.826	1.41	1.51	113.0	129.0	128.8	132.2
	66 A	2,800	1.5	210	.014	.016	.011		.047	.054	.015	.088	.123	.065	.991	1.61	1.51	110.9	128.3	127.4	130.3
	100 A	3,000	2.35	200	.028	.020	.020		.143	–	.069	.244	–	–	.661	5.15	1.82	119.9	135.3	128.8	141.2
	68 A	8,200	2.35	175	.0047	.0078	.032		.0047	.0089	.0024	.015	.021	.011	.826	.505	1.21	97.1	121.6	119.9	129.7
	69 B	4,300	2.35	195	.0071	.011	.0080		.065	.085	.015	.095	.156	.109	.661	.908	1.21	113.7	124.1	128.2	129.2
	48 B	5,300	1.5	198	.0047	.0078	.0045		.0071	.0078	.0036	.020	.021	.014	.661	.505	1.21	94.0	120.0	121.5	120.2
	40 B	5,300	1.5	197	.0047	.0067	.0045		.0047	.0070	.0024	.015	.020	.012	.661	.404	1.21	95.2	120.0	121.5	120.2
	60 A	8,200	2.35	176	.0047	.0067	.0045		.0071	.016	.0030	.020	.035	.015	.661	.404	1.21	100.7	121.6	121.5	128.3
	61 A	4,200	2.35	200	.046	.012	.0045		.027	.071	.021	.055	.128	.091	.661	1.82	1.21	110.8	125.1	126.7	131.3
	101 A	2,600	2.35	175	.087	.058	–		–	–	–	–	–	–	1.32	11.10	1.82	–	145.3	–	–
	85 B	2,600	2.35	180	.079	.068	.042		–	–	–	–	–	–	1.32	10.39	1.22	–	142.4	–	145.9

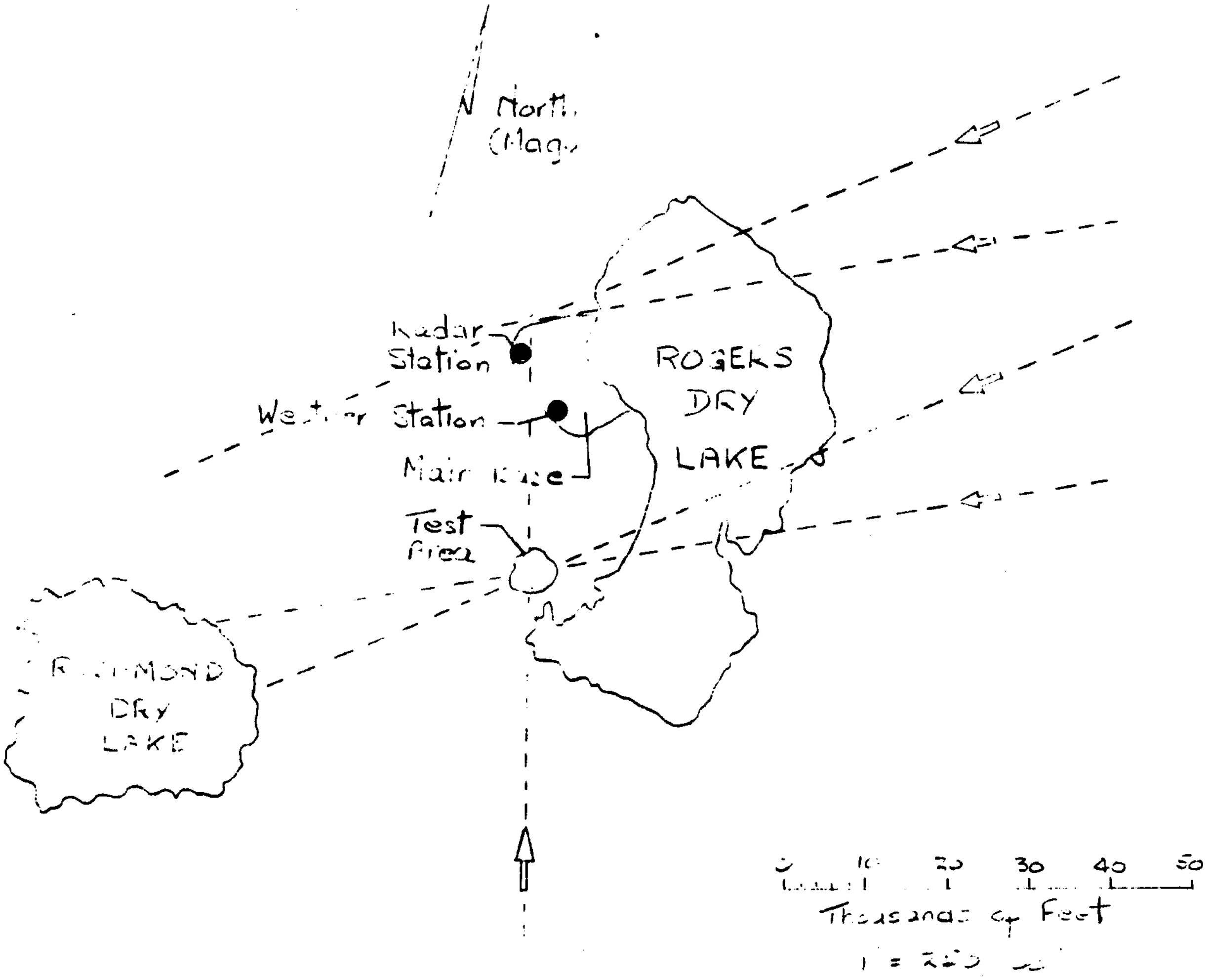
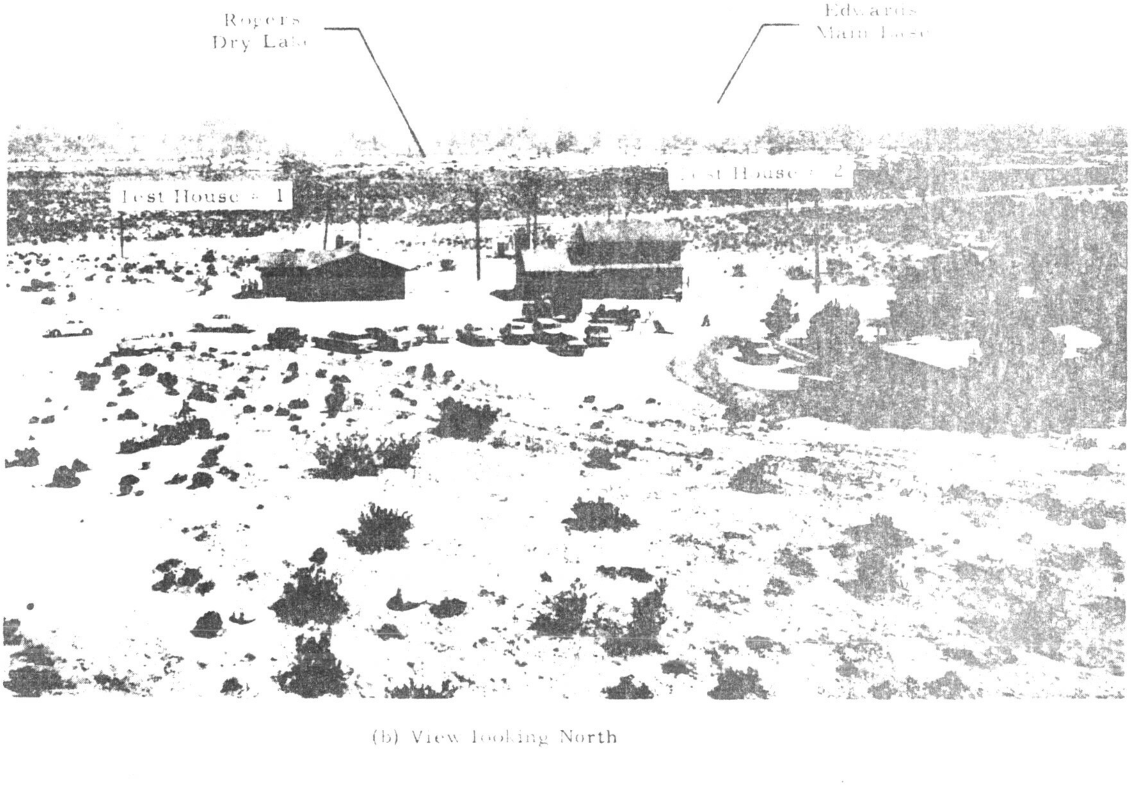


Figure 1. Arrangement of facilities and equipment including test area and aircraft flight tracks (Arrows indicate various flight tracks used for tests.).

(a) View looking East



(b) View looking North

Figure [illegible]. Photographs of test area showing type of terrain and test structures.

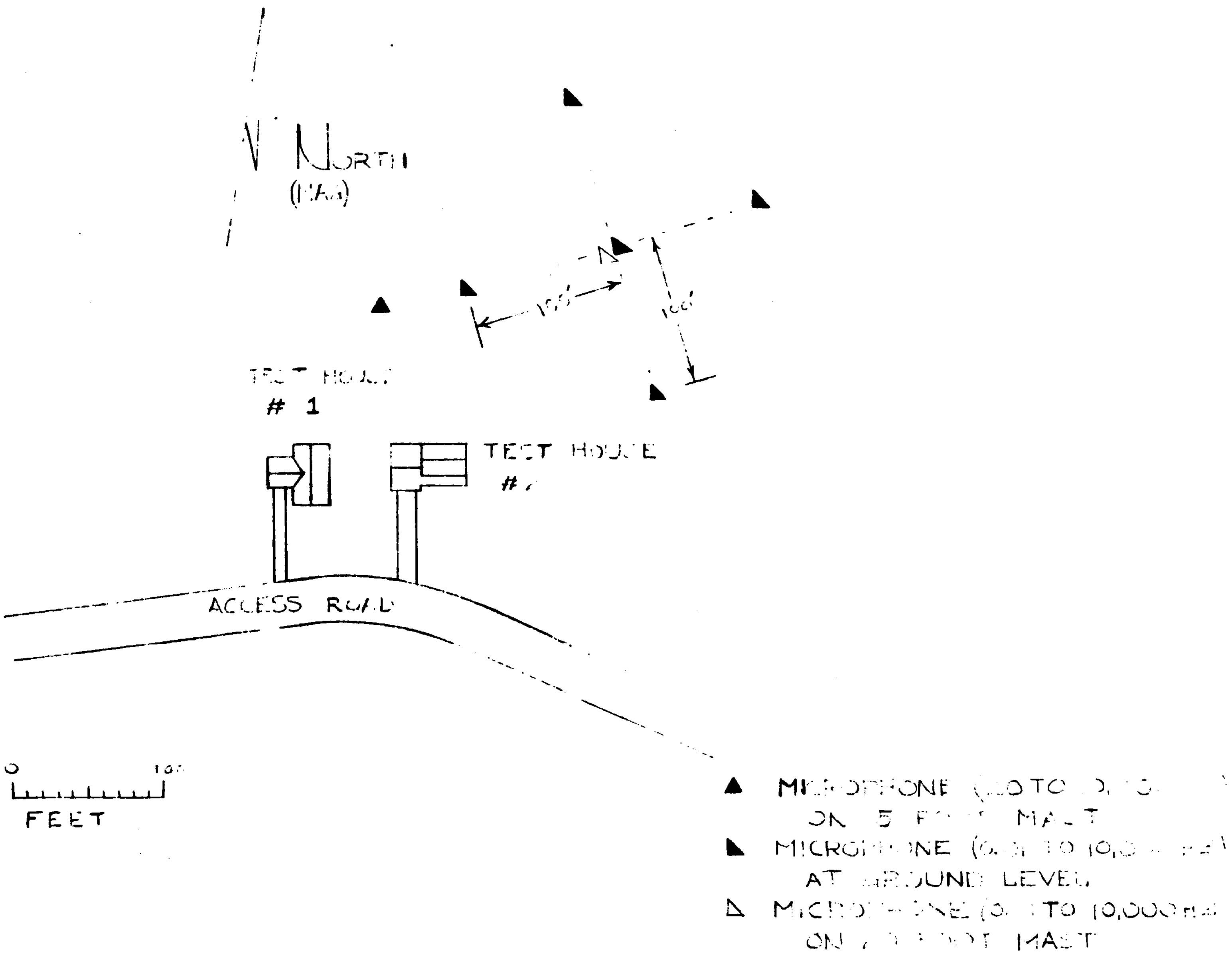


Figure 3. Planview sketch of test area showing relative locations of house structures and microphone arrays.

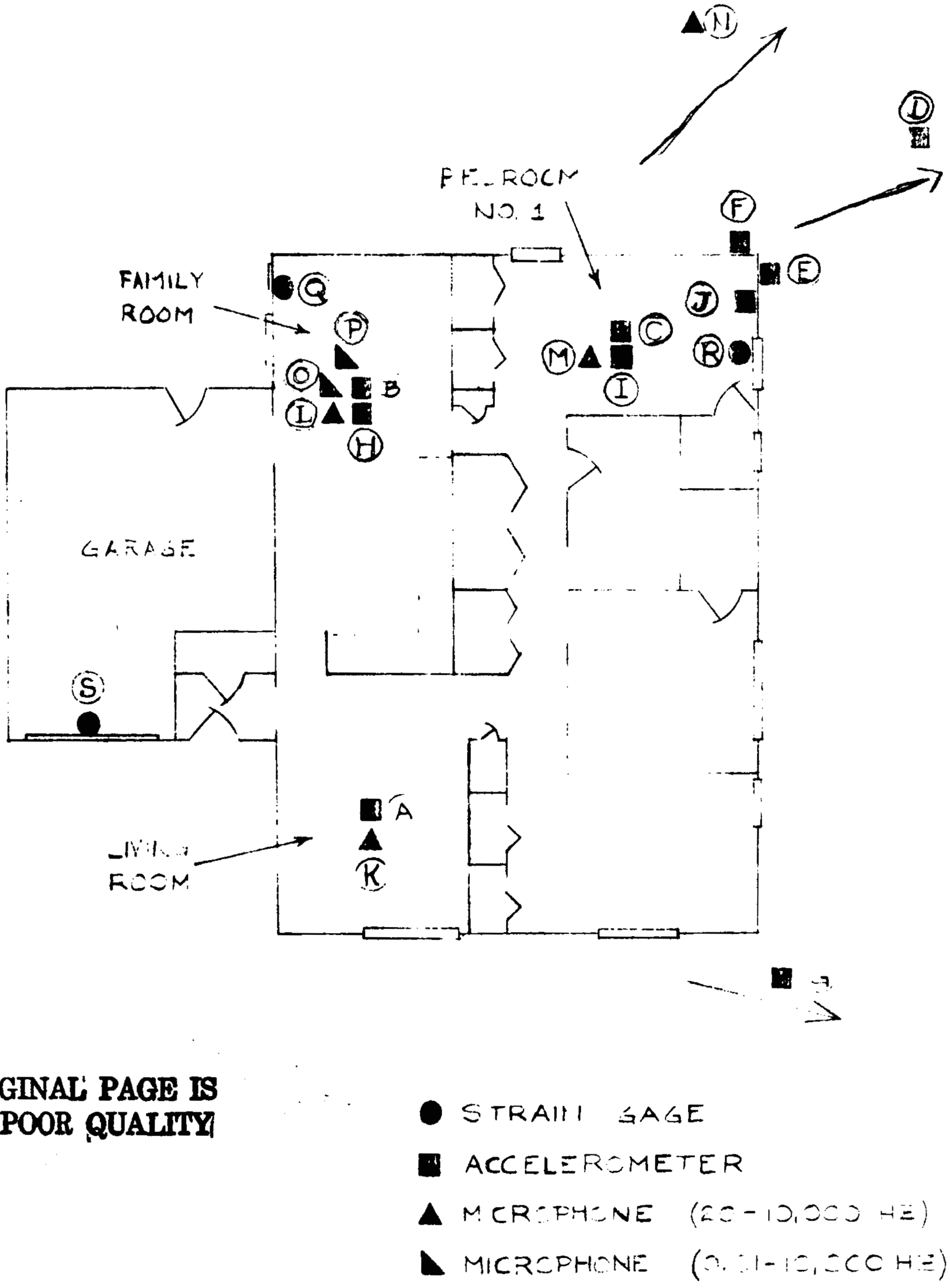
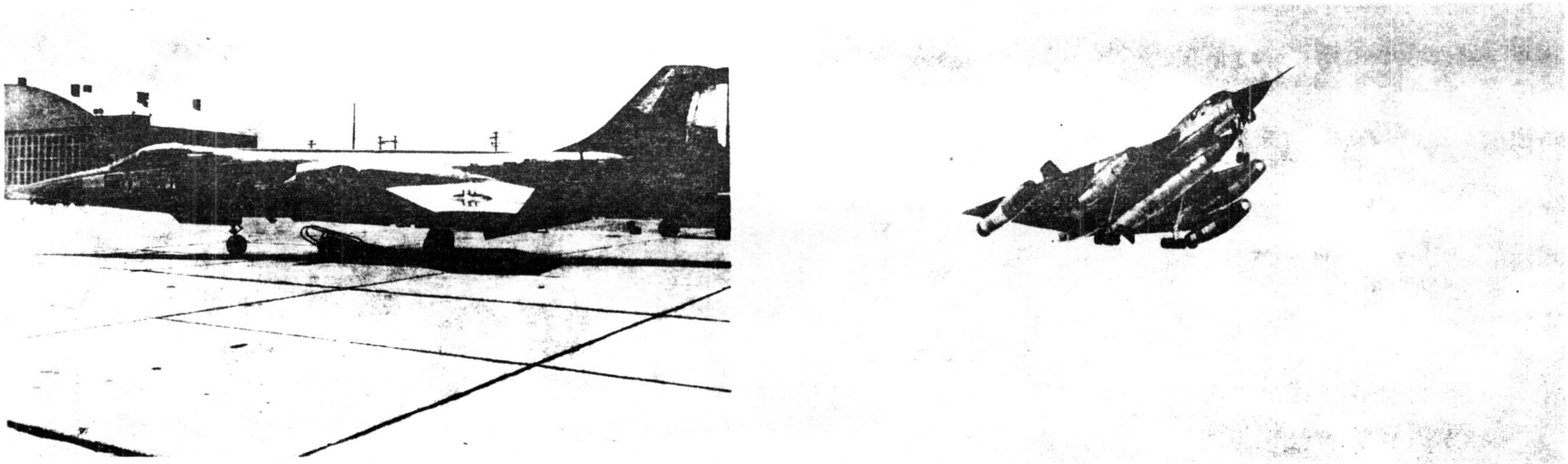
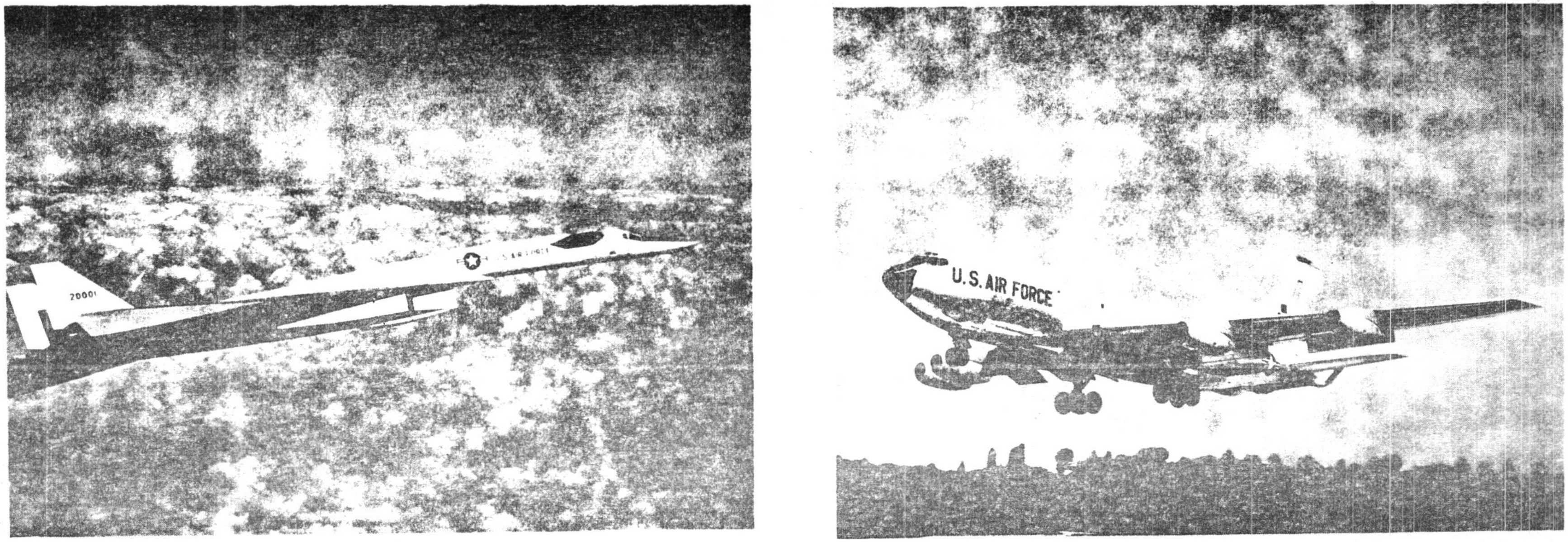


Figure 4.- Sketch of floor plan for test house No. 1 showing transducer locations.



(a) F-104

(b) B-58



(c) XB-70

(d) KC-135

Figure 5. Photographs of airplanes used in the tests.

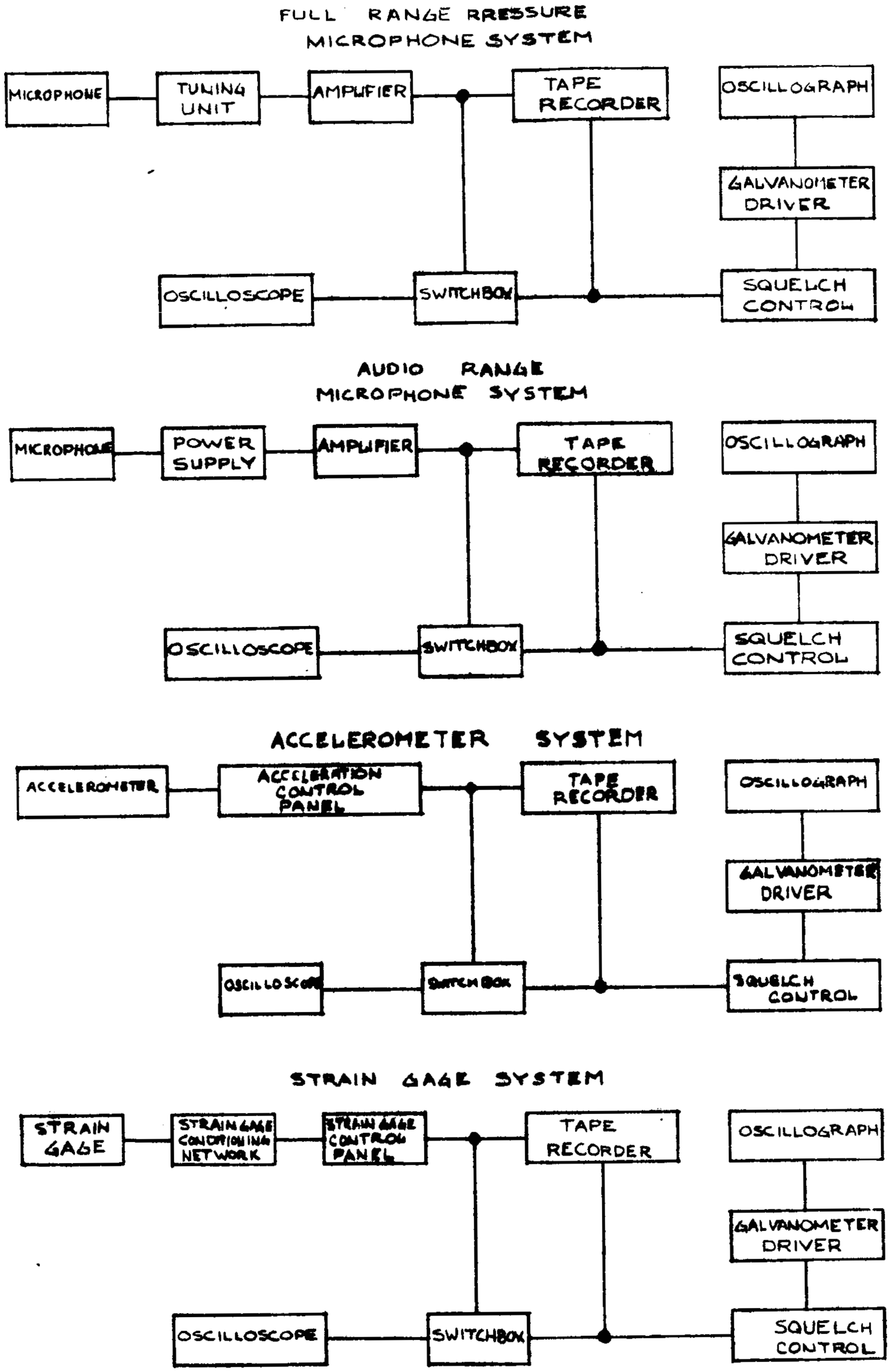
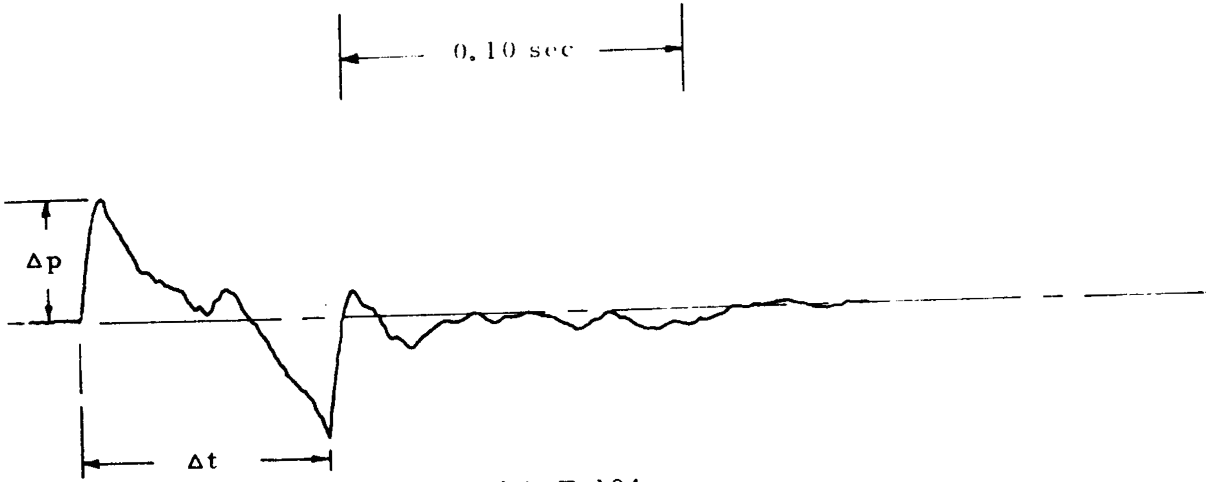


Figure 6. Block diagrams of measurement systems.

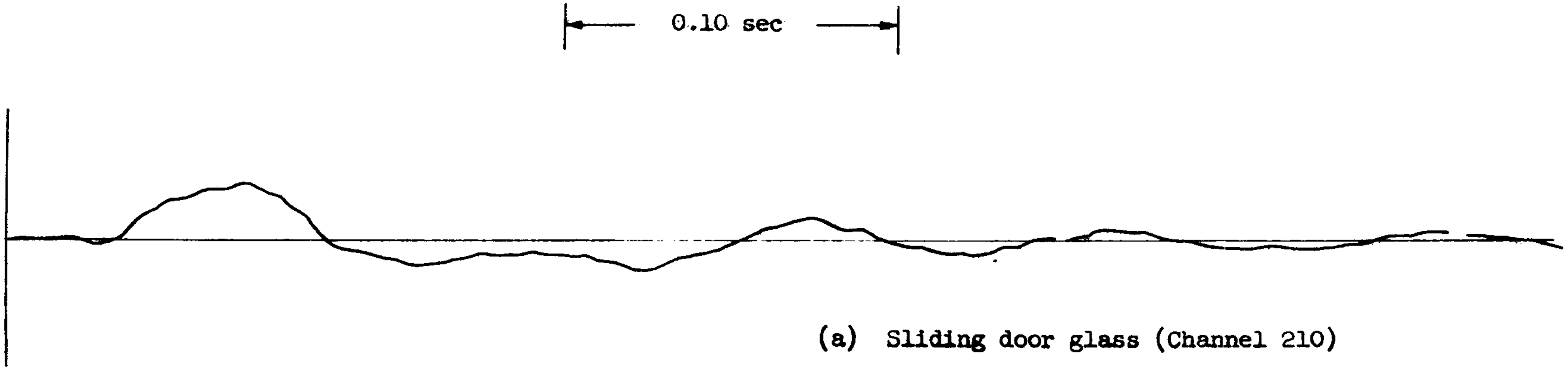


(a) F-104

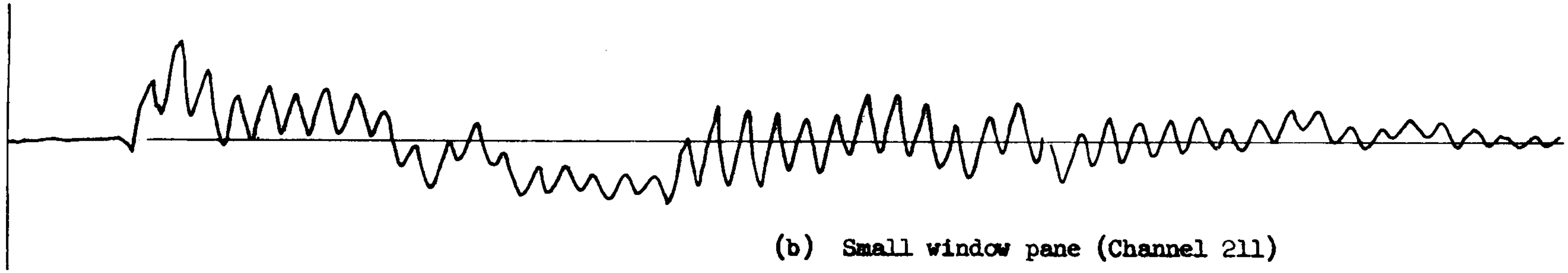
(b) B-58

(c) XB-70

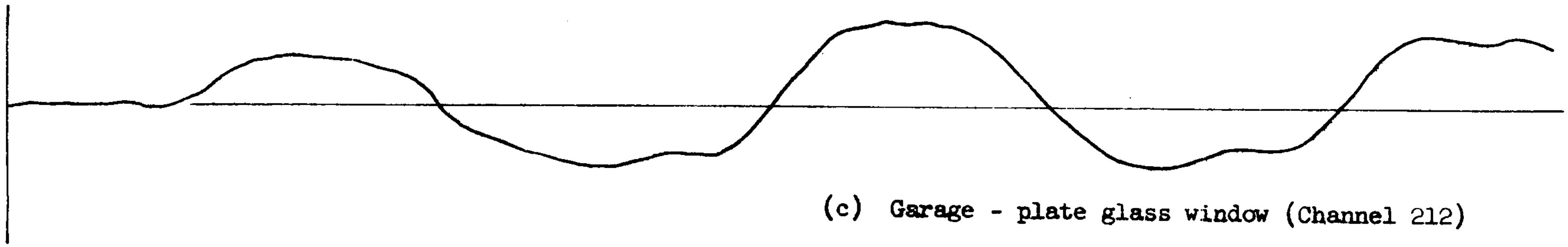
Figure 7. - Tracings of sonic boom signatures recorded during flights of the three different aircraft for which structural response data were obtained. (Δp and Δt values are listed in Tables II-IV for each data flight.)



(a) Sliding door glass (Channel 210)



(b) Small window pane (Channel 211)



(c) Garage - plate glass window (Channel 212)

Figure 8.- Tracings of records of B-58 (Mission 80 RB) sonic boom induced strain responses for three windows of House No. 1. (Strain amplitudes for each flight are listed in Tables II - IV.)

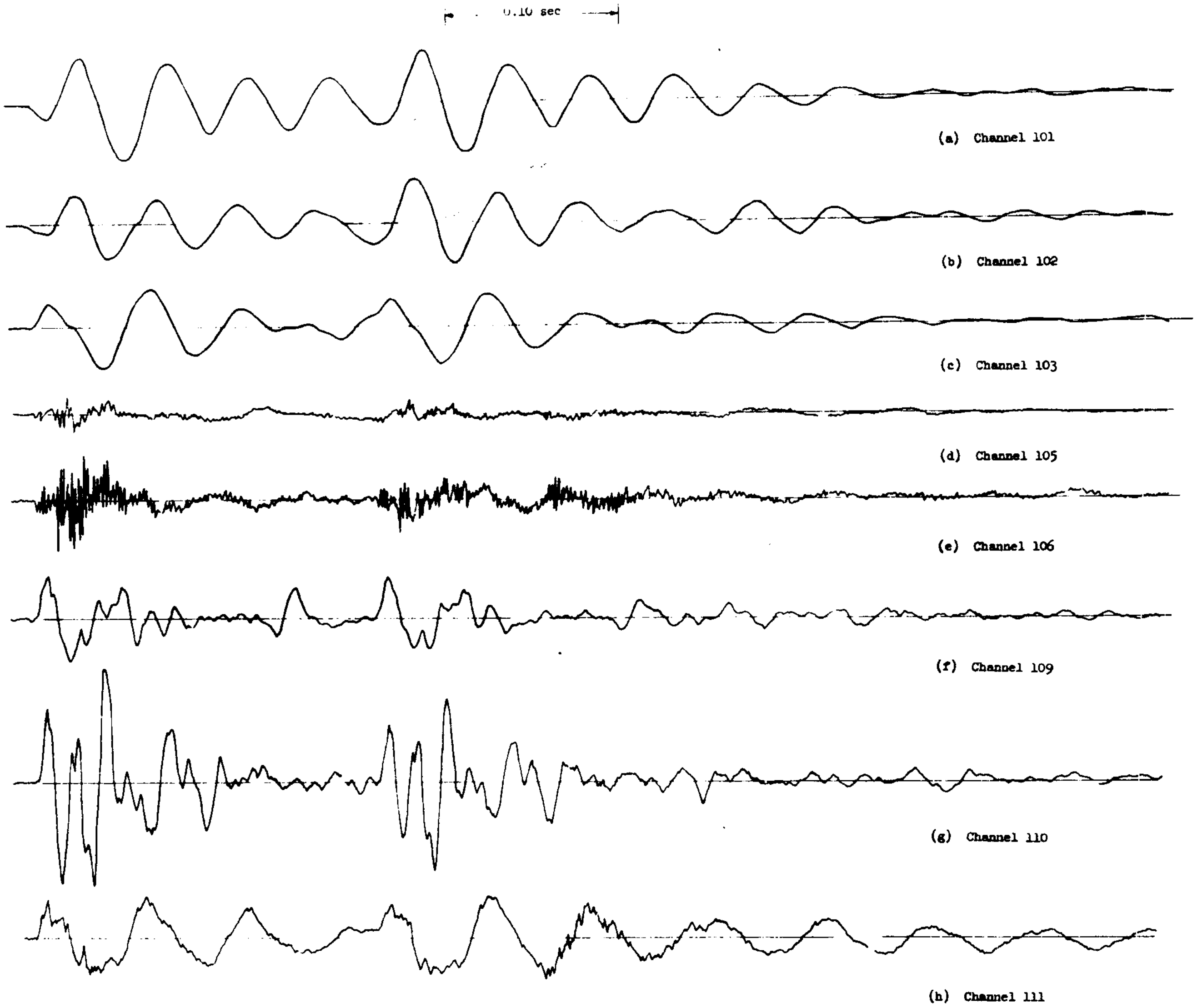
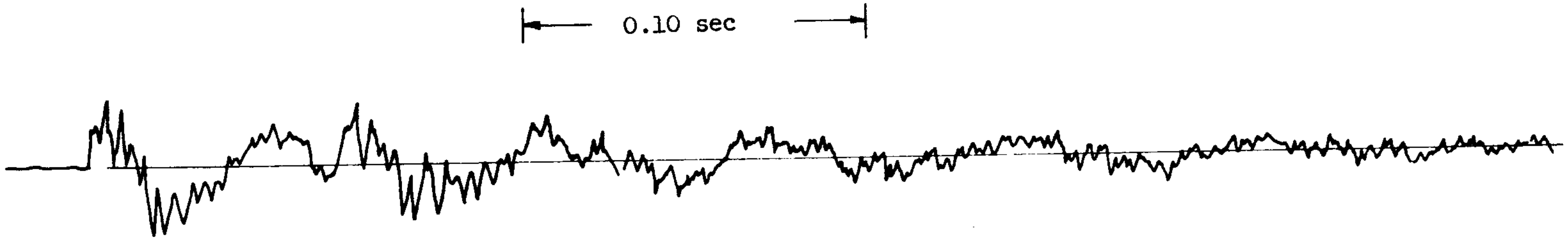
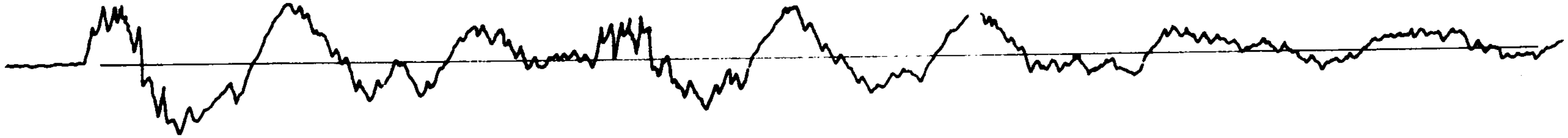


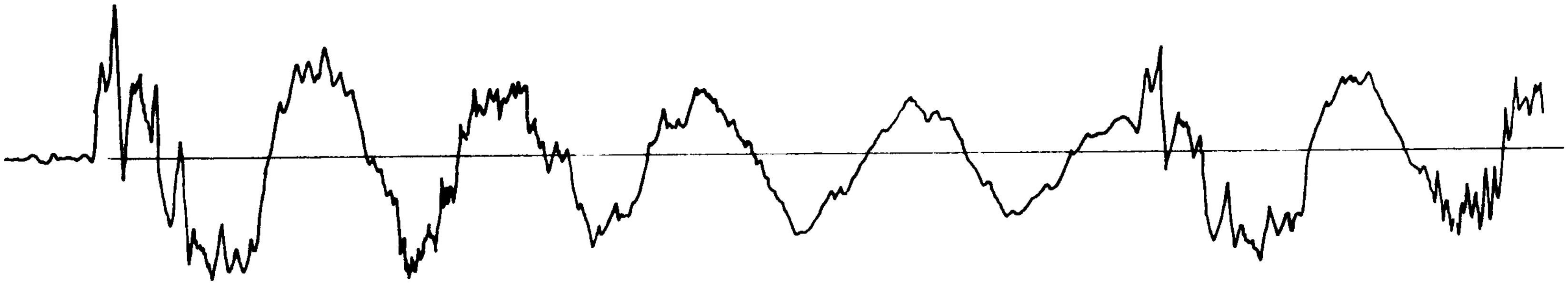
Figure 9.- Tracings of records of B-58 sonic boom induced acceleration responses for eight transducer locations as defined in Table I for Mission 18-B (Acceleration amplitudes are listed in Tables II - IV for each data flight.).



(a) F-104, Mission No. 37-B Table III

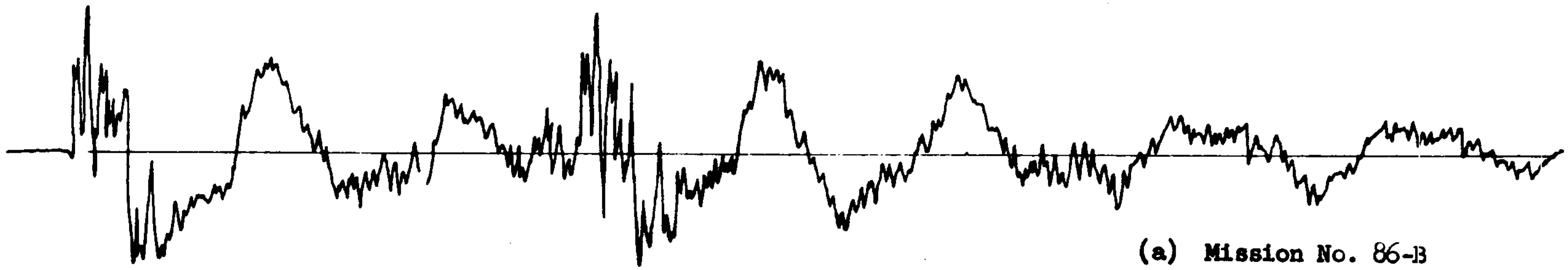


(b) B-58, Mission No. 73-A Table II

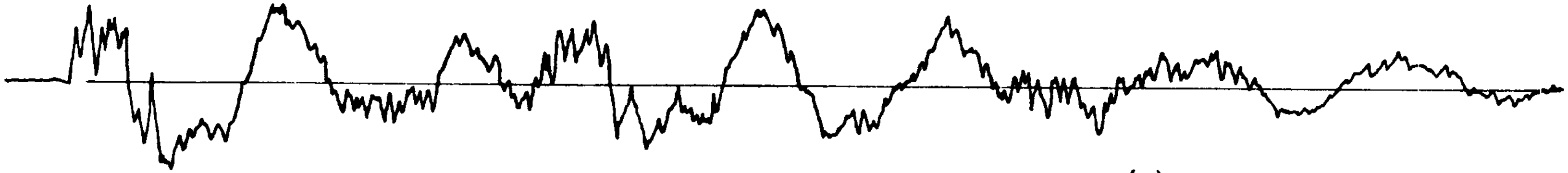


(c) B-70, Flight No. 22 Table IV

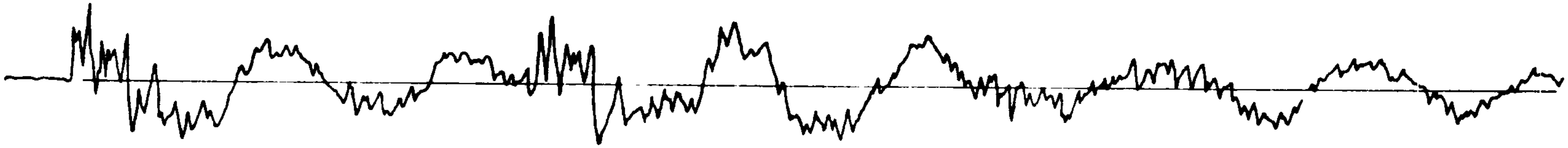
Figure 10.- Tracings of time histories of acceleration responses of the bedroom east wall (Channel 111) due to excitation from sonic booms from three aircraft.



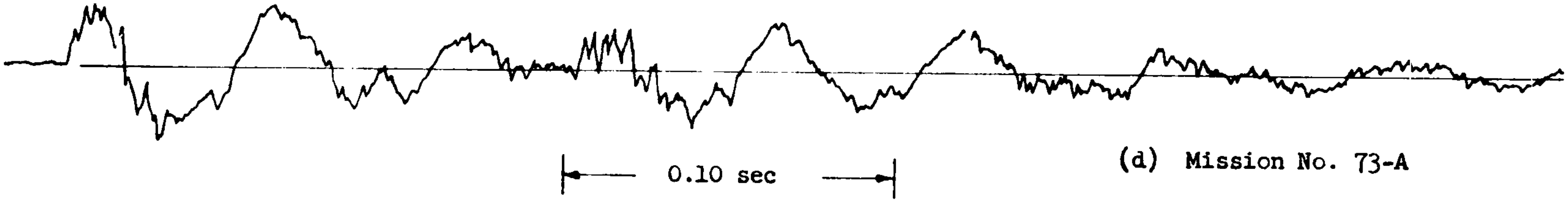
(a) Mission No. 86-B



(b) Mission No. 87-B



(c) Mission No. 80-B



(d) Mission No. 73-A

Figure 11.- Time history traces of acceleration responses of the bedroom east wall (Channel 111) due to excitation from the B-58 sonic booms overhead for several different missions.

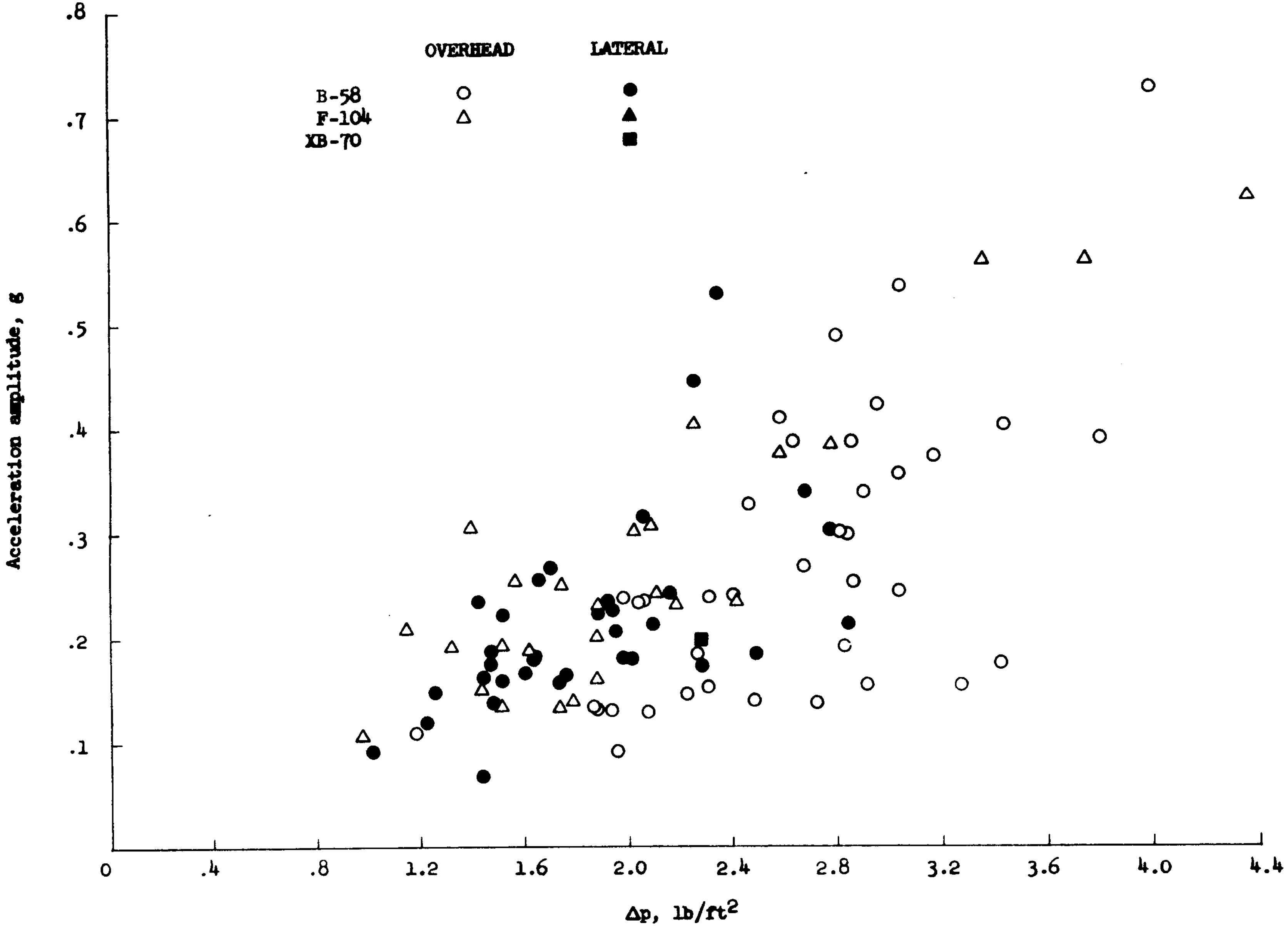


Figure 12.- Peak acceleration amplitude of bedroom east wall as function of sonic boom overpressures from three different aircraft and for two different flight track positions. Data are for Channel 111 as listed in Tables II, III, and IV.