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GROUND NOISE MEASUREMENTS DURING LANDING, TAKE-OFF, AND FLYBY OPERATIONS OF A FOUR-ENGINE TURBOPROPELLER STOL AIRPLANE

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16. Abstract

Noise measurements were obtained for a four-engine turbopropeller STOL airplane during a Federal Aviation Administration flight evaluation program at the National Aviation Facilities Experimental Center. These noise measurements involved landing-approach, take-off—climbout, and flyby operations of the airplane. A total of 13 measuring positions were used to define the noise characteristics around a simulated STOL port. The results are presented in the form of both physical and subjective measurements. An appendix is included to present tabulated values of various subjective reaction units which may be significant for the planning and operation of STOL ports.

The main source of noise produced by this vehicle was found to be the propeller, and noise levels decrease generally in accordance with the inverse-distance law for distances up to about 457 meters (1500 ft). For similar slant ranges, somewhat lower noise levels were experienced during flyby than during take-off or landing.

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SUMMARY

Noise measurements were obtained for a four-engine turbopropeller STOL airplane during a Federal Aviation Administration flight evaluation program at the National Aviation Facilities Experimental Center. These noise measurements involved landing-approach, take-off—climbout, and flyby operations of the airplane. A total of 13 measuring positions were used to define the noise characteristics around a simulated STOL port. The results are presented in the form of both physical and subjective measurements. An appendix is included to present tabulated values of various subjective reaction units which may be significant for the planning and operation of STOL ports.

The main source of noise produced by this vehicle was found to be the propeller, and noise levels decrease generally in accordance with the inverse-distance law for distances up to about 457 meters (1500 ft). For similar slant ranges, somewhat lower noise levels were experienced during flyby than during take-off or landing.

INTRODUCTION

There has been considerable activity and interest in the development of practical commercial STOL aircraft. (See refs. 1 and 2.) For such aircraft, which involve relatively large amounts of power, noise may be of particular concern in the operation into, out of, and around airports near populated areas. (See refs. 3 and 4.) Very few systematic noise studies are available for STOL airplanes. (See refs. 5 to 9.)

The NASA, in cooperation with the Department of Transportation (DOT), obtained noise measurements on a four-engine turbopropeller STOL airplane during the Federal Aviation Administration's (FAA) STOL operational evaluation program at the National Aviation Facilities Experimental Center (NAFEC). This program provided information concerning the external noise levels of this STOL transport under controlled operating conditions. Noise measurements were obtained for 15 landing-approach, 11 take-off—

climbout, and eight flyby operations of the airplane. These operations constituted part of the approximately 150 flights conducted during the evaluation program.

The purpose of this paper is to present the results from 13 ground noise measuring stations for the 34 flights along with the pertinent airplane operating conditions, tracking information, and surface weather data. The noise data are presented in units which reflect both physical and subjective measures (appendix) and are representative of those anticipated in communities near STOL ports for operations of this type of aircraft.

SYMBOLS AND ABBREVIATIONS

Values are given in both SI and U.S. Customary Units. The measurements and calculations were made in U.S. Customary Units.

B number of blades

d duration of 10-dB-down point, sec

h altitude, meters (ft)

m order of harmonic

V_2 best angle-of-climb speed, knots

x distance along runway center line, meters (ft)

y lateral displacement from runway center line, meters (ft)

Subscripts:

av average

t1 tone correction by method proposed in reference 16 and modified in reference 15

t2 tone correction by method of reference 17

Abbreviations:

dB decibel, unit of measure of sound pressure level, ref. 0.0002 dyne/cm^2

EPNL(FAA) effective perceived noise level obtained by integration method specified by FAA for aircraft certification

EPNL(FAA)(app) effective perceived noise level obtained by estimation method specified by FAA for aircraft certification

ILS instrument landing system

OASPL overall sound pressure level

Notation used from reference 12:

EPNdB effective perceived noise level obtained by integration method

EEPNdB effective perceived noise level obtained by estimation method

Max. dB(A) maximum OASPL that would be observed on standard sound-level meter containing "A" spectral-weighting network (ref. 13)

Max. dB(C) maximum OASPL that would be observed on standard sound-level meter containing "C" spectral-weighting network (ref. 13)

Max. dB(N) maximum OASPL that employs spectral weighting derived from same research data underlying concept of perceived noisiness (ref. 14)

Max. PNdB maximum value of perceived noise level calculated with aid of noy tables (calculated during temporal course of given aircraft sound)

Peak PNdB perceived noise level as calculated from highest levels reached in individual 1/3-octave bands during noise exposure

APPARATUS AND METHODS

Test Conditions

The tests were conducted at the FAA NAFEC located near Atlantic City, New Jersey, during November 1968 and June 1969. The main runway (13-31), which is 3000 meters (10 000 ft) long, was used. The elevation of the test area is 23 meters (76 ft) above sea level. The photographs of figure 1 show views of the general test area of runway 13-31, the test airplane, and the noise recording vans and microphones. Figure 2 is a plan-view sketch of the NAFEC test area showing the noise measuring positions with respect to the STOL port and airplane flight track. Aircraft tracking was accomplished by the use of phototheodolites. Three mobile recording vehicles were used to provide a total of eight microphones. The first day of noise measurements involved microphones at positions 1 to 5 on the landing-approach path. Measurements on the second day required the staffing of positions T/O 1 to T/O 3 for side-line noise levels and positions 6 to 10 for take-off—climbout flights. The noise during constant-altitude flyby was measured at position 6 only. All measurements were made in accordance with the recommendations of reference 10.

Airplane Description

The plan, profile, and frontal views of the airplane, along with the main dimensions, are shown in the three-view drawing of figure 3. The airplane is powered by four free turbine engines, which drive four three-blade cross-shafted propellers of 4.50-meter (14.76-ft) diameter. An aft and forward gear reduction box provides the turbine and propeller speeds shown in the following table (ref. 11):

Regime	Engine rpm	Propeller rpm	Propeller shaft power	
			kW	hp
Take-off	33 500	1240 (100%)	1052	1431
Maximum continuous	32 600	1180 (97%)	909	1236
Cruising	32 100	1050 (85%)	819	1113
Flight idle	25 000	950 (76%)	177	241

The airplane was equipped with a full-span segmented flap system. The gross weight of the airplane during the tests varied from about 18 860 to 20 450 kg (41 580 to 45 060 lb).

Airplane Operations

The STOL operational evaluation program was performed by FAA personnel and consisted of flights involving landing-approach, take-off—climbout, and constant-altitude flyby operations. These included straight-in and offset landing approaches, missed approaches, various stopping methods, and straight-out and turning take-off—climbout. Noise measurements were obtained only for straight-in landing approaches (with the exception of one missed-approach landing operation) and straight-out take-off—climbout. The flights for which noise measurements were obtained are given in table I along with dates and times of operations and gross weights. It will be noted that the noise tests involved 15 landing, 11 take-off—climbout, and eight flyby operations. The various modes of operation are shown in the following table:

Setting	Mode of operation				
	Take-off	Climbout[a]	Landing[b]	Flyby	
Propeller speed, percent	100	95	100	97	100
Power (per engine), kW (hp)	Take-off power	As required	As required	960 (1300)	1050 (1430)
Flaps, deg	45	45	95	0	0
Landing gear . . .	Retract after take-off	Up	Down	Up	Up

[a]Above 143 meters (470 ft).

[b]From outer marker, 3.2 km (2 miles) to touchdown.

Landing approach.- The airplane was vectored into position to intercept the intermediate fix point at approximately 5 km (3 miles) from touchdown at an altitude of about 500 meters (1650 ft). The flight then proceeded at this altitude until it intercepted the $7\frac{1}{2}^{\circ}$ ILS approach at the outer marker (3.2 km (2 miles) from touchdown). The pilot proceeded down this glide slope at 64 knots to a normal landing. Touchdown was made on the runway center line and in no case short of the beginning of the simulated STOL port. (See origin in fig. 2.) The stopping method after touchdown was selected from several combinations of brakes and propeller reverse. All landings were made to a complete stop. For the missed approach (flight 50), the airplane proceeded with a normal landing approach until passing through 82 meters (270 ft) altitude. At that time the airplane pulled up and made a 180° turn back to the outer marker.

Take-off—climbout.- The take-off roll was initiated at the east end of the simulated STOL port. (See fig. 2.) Take-off power was applied approximately 6 seconds prior to brake release. On reaching rotation velocity (60 knots), the airplane was rotated to 7° angle of attack and maintained at 7° after becoming airborne. The landing gear was retracted after lift-off. After reaching an altitude of 10.7 meters (35 ft) at V_2 (73 knots), the airplane climbed at V_2 to 326 meters (1070 ft) in the take-off configuration with propeller speed reduced to 95 percent at 143 meters (470 ft).

Constant-altitude flyby.- Flyby operations were conducted at altitudes of 152, 305, and 610 meters (500, 1000, and 2000 ft) above the runway and over microphone position 6. Two runs were made at each of the three altitudes at about 97 percent propeller speed and two passes at 305 meters (1000 ft) at 100 percent propeller speed. The airplane alternated direction along runway 13-31 for each pair of passes and was in the clean configuration (gear and flaps up), and engine power was set prior to entering the test area. These conditions were held for about 1.6 km (1 mile) ahead of and 1.6 km (1 mile) beyond the overhead position of microphone 6. The forward speed for these flybys ranged from 215 to 235 knots. (See table I(c).)

The airplane was flown over the noise measuring stations, which were positioned such as to obtain measurements during landing approach, take-off roll and climbout, and flyby as suggested by the diagram in figure 4. During these operations, positioning information was obtained with regard to the airplane altitude, lateral distance from the extended runway center line, and distance from the start of take-off roll and landing approach by means of two phototheodolite stations. The altitude h and slant-range distance for each flight listed in table I at each of the noise measuring stations shown in figure 2 are listed in tables II, III, and IV. Also listed in tables II, III, and IV are the average values of altitude and slant range for all flights at each noise measuring station.

In figure 5 are plotted the altitude-distance profiles for the landing-approach and take-off—climbout operations of all the noise flights. Also shown are the positions of the noise measuring stations, landing threshold, start of roll, and power-reduction point. The circle symbols represent the average altitude of the airplane over each noise measuring position as given in tables II and III, and the vertical bars represent the range of altitudes flown. The change in climbout profile near position 8 results from the power reduction occurring at about 143 meters (470 ft) altitude.

It should be noted that on flights 15, 18, and 21 for the take-off—climbout operations (table III), the airplane initiated roll at a position approximately 152 meters (500 ft) beyond the designated start point (east end of simulated STOL port (fig. 2)). As a result, the altitudes obtained by the airplane over each of the noise positions for these flights were somewhat lower than those for most of the operations which began at the east end of the STOL port. This factor accounts for most of the altitude spread shown at each noise position in figure 5.

Atmospheric Conditions

In order to assure valid results, noise measurements were made only when the weather was generally clear with low surface winds (less than 10 knots). Surface-condition readings were obtained from an onsite measurement station positioned near the STOL port. The available data on surface temperature and wind velocity and direction for each of the flights during the three days of noise measurements are given in table I. It can be noted that surface temperatures ranged from about 279° to 292° K (43° to 66° F).

Noise Measurements

Data acquisition.- The noise measuring systems used in these tests consisted of microphones, preamplifiers, sound-level meters, and tape recorders. The microphones were of a commercially available piezoelectric type fitted with windscreens and positioned about 1.5 meters (5 ft) above ground level. They had frequency responses flat to within ±0.5 dB over the frequency range of 30 to 10 000 Hz. The outputs of the eight microphones were recorded on multichannel frequency-modulated tape recorders. Three recording stations were used, one handling two microphone systems and two handling three microphone systems. The entire sound measurement system was calibrated in the field by means of conventional discrete frequency acoustic calibrators before, during, and after the flight measurements.

Data reduction and analysis.- The analog tape recordings made in the field were digitized for computing the overall noise level and the effective perceived noise levels. The details of the system used in obtaining these measurements are given in reference 12 along with detailed descriptions of the subjective measurements used in the appendix of the present paper.

RESULTS AND DISCUSSION

The noise measurement results obtained during these tests are presented in figures 6 to 11 in the form of typical noise time histories, narrow-band frequency spectra, 1/3-octave band frequency spectra, and summary plots of noise level as a function of distance for the landing-approach, take-off—climbout, and flyby operations. In addition, the detailed listing of Max. dB(C), which for this case is equivalent to overall sound pressure level, obtained at each station for each flight operation is given in tables II, III, and IV, for the landing-approach, take-off—climbout, and flyby operations, respectively. Also shown in these tables are the altitude and slant range.

Noise Time Histories

In figure 6 are presented typical time histories of sound pressure level in terms of Max. dB(C) as measured at the various microphone positions during operation of the STOL airplane. Also shown are definitions of the maximum levels and time durations. Figure 6(a) is for landing approach (flight 9), figure 6(b) is for take-off (flight 39), figure 6(c) is for climbout (flight 39), and figure 6(d) is for flyby (flights 102, 103, 105, and 107).

Landing approach.- In figure 6(a) it can be noted that, in general, the sound pressure levels increase as the airplane approaches the measuring station, reach a maximum as the airplane passes over, and decrease as the airplane passes beyond the measuring station. Since altitude is decreasing as the airplane passes from position 1 to position 5, the overall noise levels increase and time durations of the flyover noise decrease. The time durations measured at the 10-dB-down point vary from 3 to 16 seconds, depending on the airplane altitude. The second peak in noise time history measured at position 5 occurs after the airplane touches down on the runway, passes by the station, and reverses propellers.

Take-off—climbout.- Similar results are shown in figures 6(b) and 6(c) for the take-off—climbout operations. The noise levels decrease and time durations increase as airplane altitude increases. Since the take-off—climbout and landing-approach profiles are about the same, the time durations measured at the 10-dB-down point on the noise time histories would also be similar (the take-off—climbout d_{av} varies from 3 to 15 seconds, depending on airplane altitude.)

Constant-altitude flyby.- In figure 6(d) are presented flyby noise time histories measured at microphone position 6 for flights 102, 103, and 105, corresponding to altitudes of 579, 248, and 101 meters (1900, 814, and 331 ft), respectively, for a propeller speed of 97 percent and an airspeed of about 200 knots and for flight 107, corresponding to an altitude of 248 meters (814 ft), for a propeller speed of 100 percent. Increasing altitude for the same power setting results in a decrease in noise level and an increase in time duration. It can be seen that at equal altitudes, there is an increase of 1 to 2 dB in sound pressure level for 100 percent propeller rotational speed over that for 97 percent speed. However, the time duration does decrease slightly for the higher rotational speed because the airspeed has increased somewhat.

Noise Spectra

In figure 7 are presented typical 1/3-octave band spectra at the time of occurrence of the Max. dB(C) in the noise time histories of figure 6. The 1/3-octave band levels are plotted as a function of band center frequency. Also shown are the Max. dB(C) levels of each spectrum corresponding to the maximum levels shown in figure 6. In addition to the 1/3-octave band data, narrow-band spectra made during static runup are presented in figure 8.

Landing approach.- In figure 7(a) are shown the spectra for five microphone positions during the landing-approach operations. The spectra are typical of turbine-driven propeller airplanes; that is, a significant amount of noise energy is contained in the lower end of the spectrum because of propeller rotational noise and because little turbine exhaust noise is evident. The operating conditions of propellers are such as to produce a fundamental blade passage frequency of about 60 Hz. Evidence of turbine noise is indicated by the peak at about 8 kHz (positions 3, 4, and 5, for example).

Take-off—climbout.- Similar spectral results are shown for the take-off—climbout operations of figures 7(b) and 7(c). Of particular interest is the spectrum shape measured at the 457-meter (1500-ft) side-line position T/O 3. Evidence of large ground-to-ground noise attenuations is apparent, as suggested by the lack of noise energy above about

0.3 kHz. Note that as the airplane takes off and begins its climb, the noise levels decrease and the time duration increases as airplane altitude increases.

Constant-altitude flyby.- Spectral results for each of the flyby operations are shown in figure 7(d). Again the spectra are typical of a propeller-driven airplane in that most of the energy is contained in the lower frequencies. It is also evident that as the altitude increases, the high-frequency content of the noise decreases because of atmospheric attenuation. Note that there is very little change between the spectra for the repeat runs and also between the spectra measured for the 244-meter (800-ft) altitude flights at 97 percent and 100 percent propeller speeds.

Ground static runup.- In figure 8 are presented narrow-band analyses (3-Hz bandwidth) of a ground static runup of one engine (No. 4) of the test airplane at 97 percent and 100 percent propeller speed. These data were taken at a radius of 61 m (200 ft) in the plane of the propeller. For the static noise tests, all propellers except No. 4 were decoupled. Figure 8 presents narrow-band analyses only to 500 Hz. Further analysis has shown that frequency components above this limit are at least 20 dB below the peak amplitude of figure 8 and do not contribute significantly to the OASPL.

The prominent noise components, shown as spikes in figure 8, are related to the rotational speed of the propeller. These rotational-noise components are identified by an mB number, where m is the order of the harmonic and B is the number of blades (B = 3 for this airplane). For both rotational speeds, the fundamental and the first few harmonics are identifiable. However, the higher harmonics mix with the broad-band noise, which is thought to be associated with the propeller and turbine.

Average Noise Levels With Distance

In figure 9 are presented the noise levels as measured along the ground track of the STOL airplane during landing-approach and take-off—climbout operations. In figure 10 are presented the noise levels as a function of altitude for the constant-altitude flyby operations. Figure 11 is a summary of the noise levels associated with the take-off—climbout, landing-approach, and flyby operations along with data from reference 9.

Landing approach.- Plotted in figure 9(a) are the Max. dB(C) noise levels as a function of distance from landing threshold. The circle symbols represent the average value from all 15 flights at each of the four measuring positions 1 to 4, and the vertical bars represent the range of noise levels encountered. (See table II.) Also shown in figure 9(a) are the average altitude and slant-range distance of the airplane over each of the noise measuring positions used. It will be noted that at position 4, the slant-range distance from the noise position to the airplane is more strongly influenced by the lateral distance than by altitude. Note from figure 9(a) that the noise levels increase as the distance from the threshold decreases since the airplane altitude is also decreasing.

Take-off—climbout.- Similar data for the take-off—climbout operations are shown in figure 9(b), wherein the Max. dB(C) levels are plotted as a function of distance from start of take-off roll. It can be seen that the noise levels decrease as distance from start of roll increases since the airplane altitude is increasing. The spread in the vertical bars (representing the range of noise values measured) is generally greater than in the landing operations. However, somewhat greater variations in altitude were also encountered partly because of normal operations but primarily because of the different start-of-roll position for flights 15, 18, and 21 previously mentioned. (See table III.)

Another point of interest in figure 9(b) is the lack of a pronounced noise-level reduction at positions 8, 9, and 10. The take-off—climbout procedure calls for a power reduction (reduction in propeller speed from 100 to 95 percent at constant torque) upon passing through 143 meters (470 ft) altitude. The change in climbout profile due to the propeller-speed reduction is illustrated in figure 5.

Constant-altitude flyby.- Plotted in figure 10 are the Max. dB(C) noise levels for constant-altitude flyby as a function of altitude. The symbols represent the value for each of the two flights made at the three altitudes. In general, the data show that as altitude increases, the noise levels decrease, falling off at a rate approximately 6 dB for each doubling of slant-range distance. Again it is demonstrated that at constant altitude the change from 97 percent to 100 percent propeller speed does not increase the Max. dB(C) level appreciably.

Data summary.- In figure 11 the measured noise levels obtained for the STOL airplane during the landing-approach, take-off—climbout, and flyby operations are plotted as a function of slant-range distance. The data shown are the average values of all the flights in terms of Max. dB(C) as listed in tables II to IV. Also included in figure 11 are the data points (solid) from a series of tests reported in reference 9 by the manufacturer. Since the propeller rotational speed and power are not markedly different for each of the three types of operations, very little difference in noise levels would be expected, and the data are in agreement. A line having a slope of 6 dB decrease for each doubling of the slant-range distance (inverse-distance law) has been included, and the data tend to follow this line. There do appear to be noticeable differences between the landing and take-off data points, which tend to fall on the line, and the flyby data points, which fall below the line. These differences may be attributed to the beneficial effects of forward speed of the airplane and the reduction in engine power.

Subjective noise units.- The opportunity is taken to present in the appendix computations of several subjective noise units that may be of interest with regard to the planning and operation of STOL ports. These are tabulated for the information of the reader, but no attempt is made to judge their relative merits.

CONCLUDING REMARKS

Noise measurements were obtained for a four-engine turbopropeller STOL airplane during a Federal Aviation Administration Flight Evaluation Program at the National Aviation Facilities Experimental Center. These noise measurements involved landing-approach, take-off—climbout, and flyby operations of the airplane. A total of 13 measuring positions were used to define the noise characteristics around a simulated STOL port. The results are presented in the form of plots and tabulations depicting the various physical and subjective measurements.

The main source of noise produced by this vehicle is the propeller, and noise levels decrease generally in accordance with the inverse-distance law for distances up to about 457 meters (1500 ft). For similar slant ranges, somewhat lower noise levels were experienced during flyby than during take-off or landing.

Langley Research Center,
National Aeronautics and Space Administration,
Hampton, Va., October 20, 1971.

APPENDIX

CONVERSION OF MEASURED DATA TO SUBJECTIVE UNITS

Since the data obtained for this propeller-driven STOL airplane may be significant for the planning of STOL ports, the opportunity is taken to present the data in various units which are judged to be significant from a subjective reaction standpoint. The original tape records which were obtained in field measurements have been processed by broad-band filtering and digitized so that appropriate computations could be performed.

The measure of the maximum overall sound pressure level that would be observed on a standard sound-level meter containing an "A" spectral-weighting network is designated Max. dB(A). (See ref. 13.) A similar measure Max. dB(N) employs a spectral weighting that represents the inverse of the 40-noy curve. (See ref. 14.)

The measure of the maximum instantaneous value of the perceived noise level calculated by the method of reference 15 is designated Max. PNdB. It does not take into account particular pure-tone components in broad-band noise or other forms of narrow-band energy concentration. Two measures of tone-corrected maximum perceived noise level, Max. $PNdB_{t1}$ and Max. $PNdB_{t2}$, have also been evaluated. In this notation, t1 refers to a method of tone correction proposed in reference 16 and modified in reference 15. The second method of tone correction, designated by t2, was developed in reference 17.

So-called peak measures of perceived noise level are computed. These measures were designated peak PNdB, Peak $PNdB_{t1}$, and Peak $PNdB_{t2}$ to indicate, respectively, the absence of tone corrections, tone corrections as determined by the method of reference 15, and tone corrections as determined by the method of reference 17. The Peak PNdB is calculated from the highest levels reached in the individual 1/3-octave bands during the course of a given aircraft sound irrespective of time. Because the sound fields radiated from the front and back of the aircraft tend to have slightly different spectra, the Peak PNdB value for a given aircraft sound may exceed the Max. PNdB value by a few decibels.

The derivation of EPNdB, $EPNdB_{t1}$, $EPNdB_{t2}$, and EPNL(FAA) requires the computation of an integrated value of perceived noise level. The computer is required to sample the spectral properties of a given sound two times per second. A perceived noise level is thus computed every 1/2 second for the duration of the sound. One particular time sample produces the maximum perceived noise level. To compute the desired integrated value, the perceived noise levels are integrated on an antilogarithmic basis over the number of time samples for which the levels are above a threshold set at 10 dB below the maximum level. The tone corrections t1 and t2 are made according to the methods of references 15 and 17, respectively. The EPNL(FAA) and EPNdB are expressed in terms of a reference-duration unit d as defined in figure 6(a).

The method of computing EEPNdB and EPNL(FAA)(app) involves the estimation method of reference 18 and incorporates a standard reference duration of 15 seconds. According to this method, EPNL(FAA)(app) and EEPNdB are equal to Max. PNdB plus $10 \log_{10} (n/30)$, where n is the number of 1/2-second time samples for which the perceived noise levels are above a threshold set at 10 dB below Max. PNdB. In this estimation method, the assumption is made that the temporal sequence of perceived noise levels will exhibit a single symmetrical peak.

The data of tables V, VI, and VII are correlated with the flight numbers and other information presented in tables II, III, and IV. Values for each of the above units for each particular flight are presented along with average values for each series of flights. It is obvious that a range of values is obtained for the subjective units depending on whether maximum units, peak units, or effective units are used.

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TABLE I.- SUMMARY OF AIRPLANE OPERATING SCHEDULE AND SURFACE WEATHER CONDITIONS DURING STOL NOISE RUNS

(a) Landing approach

[Nov. 15, 1968]

Flight	Time	Airplane weight		Surface weather			
				Temperature		Wind velocity, knots	Wind direction, deg
		kg	lb	°K	°F		
8	0711	20 321	44 800	279.5	43.4	0	---
11	0722	20 103	44 320	279.8	44.0	2	150
14	0737	19 776	43 600	280.1	44.5	2	150
9	0749	19 595	43 200	280.4	45.1	2	170
10	0803	19 413	42 800	280.6	45.4	0	---
12	0814	19 141	42 200	280.9	46.0	0	---
27	0827	18 860	41 580	280.9	46.0	0	---
29	0955	20 049	44 200	283.7	51.0	0	---
30	1007	19 912	43 900	283.7	51.0	1	130
32	1019	19 822	43 700	283.7	51.0	1	130
33	1032	------	------	283.7	51.0	2	180
35	1055	------	------	284.3	52.1	3	180
36	1137	------	------	284.3	52.1	4	200
49	1148	------	------	284.3	52.1	4	200
50	1158	------	------	284.3	52.1	3	195

(b) Take-off—climbout

[Nov. 16, 1968; straight-out departure path]

Flight	Time	Airplane weight		Surface weather			
				Temperature		Wind velocity, knots	Wind direction, deg
		kg	lb	°K	°F		
15	0703	20 284	44 720	285.4	54.1	10	250
18	0750	19 486	42 960	283.7	51.0	2	220
21	0850	20 439	45 060	285.9	55.0	10	240
23	0911	20 099	44 310	286.5	56.0	8	270
25	0935	19 631	43 280	287.0	57.0	9	250
39	1055	------	------	288.7	60.0	3	330
40	1107	------	------	289.5	61.4	7	310
41	1117	------	------	290.4	63.1	4	300
43	1142	------	------	289.3	61.1	6	330
44	1154	------	------	289.3	61.1	4	300
51	1348	------	------	292.0	66.0	9	025

(c) Constant-altitude flyby

[June 5, 1969]

Flight	Time	Altitude		Speed, knots	Airplane weight		Propeller rpm, percent	Surface weather			
								Temperature		Wind velocity, knots	Wind direction, deg
		m	ft		kg	lb		°K	°F		
101	0550	570	1869	215	20 276	44 700	97	288.7	60.0	2	---
102	0554	579	1900	218	------	------	97	288.7	60.0	4	---
103	0558	248	815	215	------	------	97	288.7	60.0	4	---
104	0600	246	807	219	------	------	97	288.7	60.0	2	---
105	0603	101	331	215	------	------	97	289.0	60.5	5	---
106	0605	98	320	215	------	------	97	289.0	60.5	4	---
107	0608	248	813	230	------	------	100	289.0	60.5	3	---
108	0610	253	831	235	19 640	43 300	100	289.0	60.5	4	---

TABLE II.- SUMMARY OF NOISE MEASUREMENTS OBTAINED FOR LANDING-APPROACH OPERATION OF STOL AIRPLANE

Flight	Altitude, m	Altitude, ft	Slant range, m	Slant range, ft	Max. dB(C)
Microphone position 1					
8	177	580	181	594	100.0
11	196	645	201	658	97.2
14	196	644	198	649	99.3
9	198	650	200	656	100.6
10	194	636	194	636	99.5
12	187	613	191	628	99.8
27	190	624	191	627	100.2
29	186	609	188	617	99.4
30	176	578	183	601	97.6
32	193	634	194	637	100.5
33	224	734	223	733	99.0
35	173	568	177	580	97.8
36	193	632	193	632	99.5
49	186	610	186	610	98.6
50	209	686	209	686	98.3
Average	192	630	194	636	99.2
Microphone position 2					
8	143	469	146	478	100.2
11	153	501	154	504	97.5
14	154	506	156	513	99.6
9	138	453	143	468	100.0
10	146	479	146	479	101.2
12	142	467	145	477	101.2
27	147	482	148	485	101.7
29	157	516	159	521	100.2
30	138	454	145	476	99.8
32	150	492	151	494	99.1
33	168	557	171	561	96.1
35	139	457	143	469	97.6
36	155	508	155	508	100.2
49	134	441	134	441	101.7
50	167	548	168	552	98.6
Average	149	489	151	495	99.6
Microphone position 3					
8	77	254	97	317	101.8
11	55	181	65	213	104.9
14	82	290	90	296	101.1
9	75	246	84	276	105.7
10	85	278	91	298	101.7
12	84	276	95	311	103.6
27	87	289	91	298	100.3
29	75	246	82	269	103.2
30	68	224	73	239	103.5
32	78	255	84	274	102.5
33	68	223	72	235	104.3
35	79	258	83	271	103.3
36	74	244	81	265	104.1
49	81	267	94	807	105.1
50	62	205	72	237	109.6
Average	76	248	84	274	103.6
Microphone position 4					
8	34	113	54	177	108.5
11	19	63	38	126	109.8
14	42	139	54	177	106.2
9	39	127	50	165	108.8
10	47	153	56	184	106.9
12	53	174	67	221	104.2
27	31	103	49	161	110.5
29	34	110	48	157	109.4
30	35	116	50	165	110.3
32	40	131	57	186	109.2
33	30	99	44	145	109.9
35	42	139	59	195	108.8
36	44	143	25	82	106.6
49	50	163	61	200	106.7
50	66	215	77	252	110.1
Average	41	133	55	180	108.4
Microphone position 5					
8	0	0	34	110	119.7
11	1.2	4	32	105	111.2
14	1.2	4	32	105	114.2
9	2.4	8	32	104	116.1
10	1.2	4	31	103	117.6
12	3.7	12	31	101	112.9
27	5.2	17	32	106	111.5
29	.3	1	33	108	116.0
30	1.5	5	33	108	118.6
32	2.7	9	33	108	114.1
33	1.5	5	31	101	115.2
35	2.7	9	36	118	116.5
36	4.6	15	34	110	113.8
49	8.5	28	36	119	113.1
50	---	---	---	---	-----
Average	2.6	8.6	33	108	114.7

TABLE III.- SUMMARY OF NOISE MEASUREMENTS OBTAINED ON TAKE-OFF—CLIMBOUT OPERATIONS OF STOL AIRPLANE

Flight	Altitude		Slant range		Max. dB(C)
	m	ft	m	ft	
Microphone position T/O 1					
23	0	0	34	111	119.9
25	0	0	33	107	119.8
39	0	0	36	117	118.7
40	0	0	34	113	119.1
41	0	0	34	112	119.4
43	0	0	34	113	119.8
44	0	0	37	122	117.9
51	0	0	35	115	119.9
Average	0	0	35	114	119.3
Microphone position T/O 2					
18	0	0	152	500	113.2
21	0	0	152	500	110.6
23	0	0	153	501	110.7
25	0	0	151	497	111.2
39	0	0	155	507	110.9
40	0	0	153	503	110.4
41	0	0	153	502	110.8
43	0	0	153	503	110.5
44	0	0	156	512	109.4
51	0	0	154	505	109.9
Average	0	0	153	503	110.8
Microphone position T/O 3					
15	0	0	457	1500	104.9
18	0	0	457	1500	107.1
21	0	0	457	1500	105.3
23	0	0	458	1501	102.7
25	0	0	456	1497	103.1
39	0	0	459	1507	101.7
40	0	0	458	1503	100.6
41	0	0	458	1502	101.0
43	0	0	458	1503	99.7
44	0	0	461	1512	98.8
51	0	0	459	1505	98.7
Average	0	0	458	1503	102.2
Microphone position 6					
15	4	14	34	110	112.2
18	9	31	36	118	112.6
21	3	10	34	110	113.0
23	30	97	44	144	112.3
25	36	117	44	145	109.7
39	33	107	51	166	109.5
40	25	82	41	134	110.8
41	39	128	48	159	110.6
43	40	131	52	169	109.3
44	49	162	54	178	107.6
51	34	111	49	160	111.8
Average	27	90	44	145	110.9

Flight	Altitude		Slant range		Max. dB(C)
	m	ft	m	ft	
Microphone position 7					
15	42	137	50	164	112.6
18	59	195	71	234	111.0
21	42	138	57	186	111.4
23	76	249	83	273	105.8
25	97	318	98	323	103.9
39	88	290	100	329	109.8
40	85	278	89	293	106.5
41	95	312	98	322	107.3
43	105	345	108	355	107.7
44	121	397	131	429	103.4
51	91	299	97	318	111.1
Average	82	269	89	293	108.2
Microphone position 8					
15	102	335	104	340	106.4
18	133	435	138	453	104.9
21	105	345	110	361	107.4
23	142	465	145	476	104.1
25	166	543	166	544	102.4
39	141	462	148	487	101.6
40	150	491	151	497	101.3
41	147	482	148	485	100.7
43	166	544	166	546	100.3
44	173	566	181	594	101.4
51	154	505	157	516	101.1
Average	143	470	147	482	102.9
Microphone position 9					
15	149	489	149	489	102.7
18	174	572	175	575	99.7
21	180	591	182	596	102.2
23	203	666	203	667	101.8
25	221	724	221	724	99.0
39	182	597	185	608	97.7
40	200	655	200	657	98.4
41	194	637	194	637	99.3
43	218	720	218	720	99.4
44	201	659	212	697	95.4
51	213	698	214	703	96.9
Average	194	637	196	643	99.3
Microphone position 10					
15	178	584	178	585	102.0
18	200	657	201	658	99.1
21	206	677	207	680	99.8
23	227	745	227	745	97.8
25	253	831	254	833	96.7
39	221	724	221	725	98.1
40	236	775	237	778	97.1
41	229	752	230	753	97.6
43	255	837	255	837	97.4
44	252	826	265	871	94.6
51	257	844	258	845	96.4
Average	229	750	230	755	97.8

TABLE IV.- SUMMARY OF NOISE MEASUREMENTS OBTAINED FOR CONSTANT-ALTITUDE FLYBY OPERATIONS OF STOL AIRPLANE

[Microphone position 6]

Flight	Altitude		Slant range		Max. dB(C)
	m	ft	m	ft	
101	570	1869	573	1879	87.0
102	579	1900	579	1900	87.6
Average	574.4	1884.5	575.9	1889.5	87.3
103	248	814	248	815	93.1
104	246	807	246	807	95.5
Average	247	811	247	811	94.3
105	101	331	102	336	97.9
106	98	320	98	321	98.0
Average	99.2	325.5	100.1	328.5	98.5
107	248	813	249	816	94.1
108	253	831	254	833	95.1
Average	251	822	251	824	94.6

TABLE V.- SUMMARY OF SUBJECTIVE NOISE MEASUREMENTS OBTAINED FOR LANDING-APPROACH OPERATION OF STOL AIRPLANE

Flight	d_{av}, sec	Max. dB(A)	Max. dB(N)	Max. PNdB	Max. $PNdB_{t1}$	Max. $PNdB_{t2}$	Peak PNdB	Peak $PNdB_{t1}$	Peak $PNdB_{t2}$	EPNdB	$EPNdB_{t1}$	$EPNdB_{t2}$	EPNL(FAA)	EEPNdB	$EEPNdB_{t1}$	$EEPNdB_{t2}$	EPNL(FAA)(app)
Microphone position 1																	
8	12	93.5	98.7	105.8	106.6	107.5	107.0	107.0	108.8	100.9	101.5	102.9	104.7	104.7	105.2	106.7	106.7
11	14	88.3	94.2	101.2	101.8	104.5	102.6	108.6	105.8	97.9	98.0	99.6	101.4	101.4	101.8	103.0	103.0
14	11	92.4	97.6	104.4	104.7	106.5	105.7	106.0	107.8	98.8	99.2	101.3	103.1	102.6	102.9	104.8	104.8
9	11	91.9	97.8	104.6	104.6	107.9	105.9	105.9	108.5	99.9	100.3	102.5	104.3	103.3	103.3	106.0	106.0
10	12	91.4	97.2	103.5	104.3	106.6	105.8	105.8	107.4	100.0	100.5	102.8	104.1	102.9	103.3	105.9	105.9
12	11	93.6	98.7	105.0	105.0	107.4	106.7	106.7	108.6	99.8	100.1	102.1	103.9	103.6	103.6	105.8	105.8
27	11	92.3	97.9	104.5	105.4	107.1	106.3	106.3	107.9	99.9	100.5	102.2	104.0	103.2	103.8	105.6	105.6
29	14	90.5	96.0	102.7	103.6	105.9	105.1	105.1	107.3	99.1	99.5	101.5	103.3	102.0	102.8	105.0	105.0
30	13	90.6	95.7	103.1	104.2	105.2	104.6	105.4	106.5	99.2	99.7	101.3	103.1	102.4	103.4	104.6	104.6
32	12	91.7	97.8	103.9	105.6	106.5	105.9	105.9	107.5	99.4	100.1	101.7	103.5	102.6	103.6	104.7	104.7
33	15	90.0	96.1	102.3	102.5	104.7	104.3	104.3	106.0	97.5	97.9	99.7	101.5	102.0	102.5	104.2	104.2
35	13	90.5	96.5	103.7	104.5	106.0	105.3	105.3	106.9	99.6	99.9	101.5	103.3	102.9	103.4	104.8	104.8
36	11	92.1	97.6	104.4	104.4	105.9	106.0	106.0	107.6	99.7	100.0	102.0	103.8	103.0	103.0	104.6	104.6
49	14	89.3	95.4	102.5	102.5	105.3	104.2	104.2	106.1	98.7	99.1	100.9	102.7	102.3	102.5	104.3	104.3
50	15	88.6	94.9	100.9	102.4	103.2	103.7	103.7	105.4	98.4	98.9	100.7	102.5	100.9	102.1	103.5	103.5
Average	12.5	91.1	96.8	103.5	104.1	106.0	105.3	105.4	107.2	99.2	99.7	101.5	103.3	102.7	103.1	104.9	104.9
Microphone position 2																	
8	12	93.2	98.8	105.8	105.8	108.2	107.2	107.2	109.0	101.4	101.6	103.5	105.3	105.0	105.0	107.2	107.2
11	12	91.1	97.3	104.1	105.2	106.8	105.7	105.7	107.4	100.0	100.5	102.0	103.8	103.2	104.0	105.5	105.5
14	12	91.0	96.9	104.2	104.3	107.1	106.2	106.2	108.3	100.0	100.4	102.1	103.9	103.6	103.7	105.5	105.5
9	9	93.9	99.3	106.4	106.6	107.6	107.7	107.9	108.7	100.5	101.0	102.1	103.9	103.9	104.2	105.2	105.2
10	12	92.7	98.7	105.6	106.7	108.6	107.5	107.6	109.3	101.3	101.7	103.4	105.2	104.6	105.2	106.8	106.8
12	11	93.0	98.8	105.8	106.5	107.9	107.5	107.6	109.1	101.4	101.6	103.6	105.4	104.6	105.0	106.4	106.4
27	10	92.6	98.7	105.5	106.7	108.8	107.7	107.8	110.1	101.2	101.7	103.5	105.3	104.2	105.1	106.9	106.9
29	11	91.3	97.3	104.5	105.7	107.8	106.4	106.5	108.8	100.2	100.5	102.3	104.1	103.7	104.7	106.1	106.1
30	12	93.2	98.2	105.4	106.7	107.6	107.5	107.6	109.7	101.4	101.9	103.5	105.3	104.6	105.5	106.4	106.4
32	11	91.9	98.2	105.1	106.3	107.6	107.3	107.3	109.2	100.8	101.2	102.7	104.5	103.8	104.6	105.9	105.9
33	16	90.0	95.6	102.7	103.4	104.5	104.2	104.2	105.8	99.4	99.7	101.4	103.2	103.0	103.5	104.7	104.7
35	14	92.4	97.2	104.2	105.6	105.9	106.1	106.2	107.7	100.8	101.2	102.5	104.3	103.9	105.0	105.4	105.4
36	11	91.7	97.9	104.7	105.1	107.1	106.9	107.0	108.4	100.4	100.9	102.4	104.2	103.4	103.7	105.5	105.5
49	11	93.8	100.4	107.0	107.5	110.1	108.5	108.6	110.6	102.4	102.9	104.7	106.5	105.4	106.0	107.9	107.9
50	15	90.0	96.3	103.2	103.2	106.4	105.3	105.3	107.4	100.0	100.2	102.0	103.8	103.5	103.8	105.6	105.6
Average	12	92.1	98.0	104.9	105.7	107.5	106.8	106.8	108.6	100.7	101.1	102.8	104.6	104.0	104.6	106.1	106.1
Microphone position 3																	
8	7	95.1	100.7	108.3	109.1	110.4	109.6	110.2	111.6	101.9	102.5	104.2	106.0	105.0	105.1	106.7	106.7
11	5	99.5	106.3	113.6	114.5	116.6	114.8	116.8	116.9	106.1	107.4	108.5	110.3	108.8	109.7	111.3	111.3
14	7	95.5	100.9	108.3	109.1	110.0	109.7	110.2	111.8	102.2	102.8	104.0	105.8	105.3	105.5	106.7	106.7
9	7	97.1	103.1	110.0	110.6	113.3	111.4	112.9	114.1	103.6	104.3	106.3	108.1	106.7	107.0	109.6	109.6
10	7	96.1	101.1	108.3	108.9	110.4	109.8	110.6	112.0	102.4	103.3	104.4	106.2	105.3	105.9	107.4	107.4
12	8	95.6	101.5	108.8	109.1	112.1	110.2	110.2	112.7	102.8	103.1	105.3	107.1	106.1	106.4	108.8	108.8
27	8	95.1	100.5	107.4	109.2	109.4	109.3	111.3	111.6	102.4	103.8	104.4	106.2	104.9	106.7	106.9	106.9
29	6	96.4	102.3	109.5	111.4	112.6	111.1	113.4	113.4	103.3	104.5	105.6	107.4	105.9	107.4	108.6	108.6
30	6	98.3	103.5	110.6	111.7	112.1	111.9	112.8	114.0	104.1	105.5	106.0	107.8	106.9	107.7	108.5	108.5
32	6	96.7	102.0	109.2	110.2	111.0	110.7	112.8	113.2	102.9	103.9	104.9	106.7	105.5	106.6	107.3	107.3
33	6	98.3	108.8	110.6	112.6	112.7	111.9	114.2	114.4	104.4	106.1	106.6	108.4	107.2	108.9	109.0	109.0
35	8	98.3	102.9	110.3	111.1	111.8	111.4	111.4	113.2	104.6	104.8	106.2	108.0	107.8	108.1	109.1	109.1
36	6	97.9	103.4	111.0	112.4	112.7	112.3	113.6	114.3	103.7	104.7	105.5	107.3	107.4	108.4	109.1	109.1
49	7	96.7	102.4	110.0	110.0	113.3	111.5	111.5	114.1	104.1	104.4	106.8	108.6	107.0	107.2	110.3	110.3
50	6	100.7	107.0	114.1	114.6	117.4	115.9	115.9	118.3	106.9	107.0	109.2	111.0	110.5	110.6	113.0	113.0
Average	7	97.2	102.8	110.0	111.0	112.4	111.4	112.5	113.7	103.7	104.5	105.9	107.7	106.7	107.4	108.8	108.8

TABLE V.- SUMMARY OF SUBJECTIVE NOISE MEASUREMENTS OBTAINED FOR LANDING-APPROACH OPERATION OF STOL AIRPLANE – Concluded

Flight	d_{av}, sec	Max. dB(A)	Max. dB(N)	Max. PNdB	Max. $PNdB_{t1}$	Max. $PNdB_{t2}$	Peak PNdB	Peak $PNdB_{t1}$	Peak $PNdB_{t2}$	EPNdB	$EPNdB_{t1}$	$EPNdB_{t2}$	EPNL(FAA)	EEPNdB	$EEPNdB_{t1}$	$EEPNdB_{t2}$	EPNL(FAA)(app)
Microphone position 4																	
8	4	102.1	108.4	115.2	115.6	117.0	115.9	115.9	117.4	106.8	107.6	108.6	110.4	110.0	110.3	111.7	111.7
11	3	103.2	109.6	116.6	118.8	118.8	117.8	117.8	119.5	107.7	108.9	109.7	111.5	110.3	111.8	112.4	112.4
14	5	100.8	107.1	114.2	114.9	116.2	115.7	117.1	117.9	106.8	107.9	109.0	110.8	109.4	110.2	111.5	111.5
9	5	102.2	108.0	115.0	115.6	117.4	115.8	115.8	118.0	107.2	107.8	109.4	111.2	110.2	110.8	112.2	112.2
10	6	99.0	105.3	112.3	114.0	115.1	114.2	116.2	116.6	105.7	107.2	108.2	110.0	108.3	110.0	111.1	111.1
12	6	97.4	103.8	111.0	113.0	113.1	112.0	113.8	113.9	104.8	106.9	106.9	108.7	107.3	109.3	109.5	109.5
27	4	103.1	109.2	116.3	117.2	118.1	117.6	117.6	119.1	108.9	109.2	110.5	112.3	111.1	112.0	112.9	112.9
29	4	101.5	108.4	115.6	115.6	117.4	116.1	116.1	117.8	107.3	107.4	109.2	111.0	110.4	110.4	112.2	112.2
30	4	102.4	109.3	116.6	116.6	118.7	116.9	116.9	119.0	107.6	108.3	109.7	111.5	110.9	110.9	113.0	113.0
32	4	101.4	108.2	115.1	115.1	117.3	115.9	117.2	118.1	106.6	107.7	108.7	110.5	109.9	110.3	111.6	111.6
33	4	102.1	108.5	115.8	115.8	117.4	116.9	116.9	118.7	107.7	107.7	109.4	111.2	110.6	110.6	112.2	112.2
35	5	100.1	107.0	114.3	114.3	116.3	115.0	116.5	117.0	106.2	107.5	108.3	110.1	109.5	109.9	111.5	111.5
36	5	99.4	105.2	112.4	112.4	114.5	113.8	113.8	115.8	105.1	105.2	107.1	108.9	107.6	108.0	109.7	109.7
49	5	98.8	104.9	112.0	112.0	114.7	113.1	113.1	115.4	104.7	105.2	107.0	108.8	107.6	108.0	109.9	109.9
50	5	102.3	107.7	114.4	114.4	117.7	115.4	115.4	118.5	107.0	107.0	109.5	111.3	110.5	110.5	113.0	113.0
Average	5	101.1	107.4	114.5	115.0	116.6	115.5	116.0	117.5	106.7	107.4	108.7	110.5	109.6	110.2	111.6	111.6
Microphone position 5																	
8	3	106.1	113.4	121.1	121.1	122.6	121.9	121.9	123.4	111.1	111.4	112.6	114.4	114.1	114.8	115.6	115.6
11	4	99.7	108.1	115.7	119.3	118.2	117.4	120.4	120.1	106.9	110.4	109.4	111.2	109.9	112.9	112.5	112.5
14	3	102.1	109.7	117.2	117.2	118.8	118.4	118.4	120.2	108.3	108.5	110.0	111.8	110.9	110.9	112.5	112.5
9	3	103.7	110.5	118.0	118.0	119.8	119.2	119.2	121.1	109.0	109.3	110.8	112.6	111.6	112.2	113.5	113.5
10	6	104.6	111.7	119.1	119.1	120.6	120.8	120.8	122.7	111.6	111.7	113.4	115.2	115.4	115.4	117.0	117.0
12	4	101.1	109.0	116.6	118.9	118.8	117.9	118.1	120.1	108.2	109.1	110.3	112.1	110.8	112.5	113.0	113.0
27	3	101.0	108.9	116.0	117.2	118.0	117.8	117.8	119.8	106.8	108.4	109.2	111.0	109.7	110.9	111.7	111.7
29	3	101.4	109.6	117.3	118.6	118.9	118.2	120.9	120.4	108.2	109.7	110.3	112.1	111.0	112.3	113.2	113.2
30	3	102.0	109.9	117.3	119.8	119.0	118.8	121.4	120.7	108.1	110.9	110.2	112.0	111.0	113.4	113.3	113.3
32	3	102.6	109.9	117.4	119.7	119.4	118.8	121.1	120.7	108.1	110.7	110.0	111.8	111.1	113.4	113.0	113.0
33	7	103.0	110.3	117.7	120.7	119.8	119.7	122.3	121.9	110.9	112.0	112.9	114.7	115.0	114.4	117.1	117.1
35	4	102.0	109.5	117.3	118.9	119.1	118.2	120.3	120.2	108.6	110.5	110.5	112.3	111.5	113.7	113.4	113.4
36	5	102.4	110.0	117.3	117.3	119.0	118.6	118.6	120.4	108.3	108.5	110.1	111.9	111.0	111.0	112.7	112.7
49	4	103.6	110.0	116.8	118.2	118.6	118.3	120.4	124.9	108.3	109.5	110.1	111.9	111.1	113.5	113.3	113.3
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Average	4	102.5	110.0	117.5	118.9	119.3	118.9	120.1	121.1	108.7	110.0	110.7	112.5	111.7	113.0	113.7	113.7

TABLE VI.- SUMMARY OF SUBJECTIVE NOISE MEASUREMENTS OBTAINED ON TAKE-OFF—CLIMBOUT OPERATION OF STOL AIRPLANE

Flight	d_{av}, sec	Max. dB(A)	Max. dB(N)	Max. PNdB	Max. $PNdB_{t1}$	Max. $PNdB_{t2}$	Peak PNdB	Peak $PNdB_{t1}$	Peak $PNdB_{t2}$	EPNdB	$EPNdB_{t1}$	$EPNdB_{t2}$	EPNL(FAA)	EEPNdB	$EEPNdB_{t1}$	$EEPNdB_{t2}$	EPNL(FAA)(app)
Microphone position T/O 1																	
23	4	*104.9*	*112.9*	*120.4*	*120.4*	*122.3*	*120.8*	*121.1*	*122.7*	*110.4*	*110.8*	*112.1*	*113.9*	*114.7*	*114.7*	*116.0*	*116.0*
25	3	105.6	113.1	120.8	120.8	122.7	121.2	121.3	123.1	110.2	110.5	112.0	113.5	114.5	114.5	116.3	116.3
39	3	105.9	112.9	120.3	120.3	122.5	120.5	120.7	122.7	110.1	110.6	111.8	113.6	113.9	114.5	115.5	115.5
40	3	105.9	113.0	120.6	120.6	122.5	120.8	121.0	122.7	110.4	110.8	111.9	113.7	114.3	114.3	115.5	115.5
41	3	105.7	112.7	120.5	120.7	122.2	121.0	121.2	122.6	110.2	110.7	111.6	113.4	114.2	114.3	115.2	115.2
43	3	106.0	113.2	121.1	121.1	122.9	121.4	121.6	123.2	110.4	111.0	112.1	113.9	114.2	114.8	115.9	115.9
44	3	105.0	112.0	119.6	119.7	121.7	120.1	120.4	122.1	109.7	110.2	111.3	113.1	113.3	114.0	114.7	114.7
51	3	*106.7*	*113.4*	*121.0*	*121.0*	*122.7*	*121.6*	*121.8*	*123.3*	*111.0*	*111.5*	*112.5*	*114.3*	*114.6*	*114.6*	*115.7*	*115.7*
Average	3	105.7	112.9	120.5	120.6	122.4	120.9	121.1	122.8	110.3	110.8	111.9	113.7	114.2	114.5	115.6	115.6
Microphone position T/O 2																	
18	8	95.2	104.9	111.2	111.4	113.5	112.1	112.3	115.1	106.0	106.1	108.4	110.2	108.4	108.6	110.8	110.8
21	7	91.1	101.9	108.1	108.1	111.1	109.1	109.2	111.7	103.0	103.1	105.4	107.2	105.1	105.1	107.8	107.8
23	12	92.6	102.3	107.3	107.5	110.6	111.5	111.5	114.5	103.3	103.6	106.3	108.1	107.5	107.6	110.4	110.4
25	*14*	*94.9*	*102.7*	*108.5*	*108.6*	*111.6*	*113.1*	*113.2*	*116.2*	*104.6*	*105.1*	*107.2*	*109.0*	*108.5*	*108.6*	*111.5*	*111.5*
39	15	93.1	102.7	107.6	107.8	110.2	111.0	111.0	113.1	104.3	104.8	107.0	108.8	107.7	108.1	110.2	110.2
40	15	94.2	102.2	107.6	108.0	109.7	111.5	111.6	113.4	105.0	105.4	107.2	109.0	107.8	108.1	109.8	109.8
41	14	93.5	102.6	107.6	107.7	109.9	111.4	111.4	113.4	104.9	105.3	107.4	109.2	107.9	108.0	110.1	110.1
43	15	94.2	102.2	107.3	107.9	109.4	111.8	111.8	113.7	105.3	105.8	107.3	109.1	108.0	108.6	110.2	110.2
44	10	97.0	103.7	110.3	110.3	111.1	112.4	112.5	114.3	103.1	104.0	105.6	107.4	108.8	108.8	109.5	109.5
51	6	91.0	101.3	106.4	106.7	109.2	108.2	108.4	110.3	99.4	99.9	102.2	104.0	103.1	103.4	105.5	105.5
Average	12	93.7	102.7	108.2	108.4	110.6	111.2	111.3	113.6	103.9	104.3	106.4	108.2	107.3	107.5	109.6	109.6
Microphone position T/O 3																	
15	12	87.3	96.4	102.8	102.8	105.6	103.4	103.4	105.9	99.3	99.3	102.3	104.1	101.8	101.8	104.8	104.8
18	14	87.6	97.6	103.8	104.0	107.6	104.3	104.5	107.6	101.3	101.4	104.5	106.3	103.4	103.7	106.8	106.8
21	13	84.8	96.3	101.7	101.7	105.2	102.7	102.8	105.9	99.1	99.4	102.7	104.5	101.3	101.3	104.9	104.9
23	17	82.7	93.7	98.2	98.6	102.4	101.9	102.3	104.7	96.4	96.8	100.0	101.8	98.8	99.3	103.2	103.2
25	*18*	*83.8*	*94.1*	*98.8*	*98.7*	*102.8*	*101.7*	*101.7*	*104.7*	*97.1*	*97.4*	*100.9*	*102.7*	*99.4*	*99.7*	*103.7*	*103.7*
39	18	86.6	92.8	99.3	99.3	103.4	102.3	102.5	104.8	97.6	98.0	101.2	103.0	100.3	100.4	104.6	104.6
40	15	84.0	91.9	96.4	96.7	102.9	99.0	99.4	102.3	93.5	94.1	98.5	100.3	97.4	97.7	103.7	103.7
41	15	84.2	92.2	96.5	96.9	103.2	100.8	100.9	103.8	95.1	95.7	99.5	101.3	97.9	98.5	104.4	104.4
43	14	86.7	93.6	98.5	98.9	102.9	100.8	101.1	103.4	94.8	95.6	100.0	101.8	99.4	100.1	104.0	104.0
44	7	89.3	95.6	103.0	103.0	104.5	103.8	103.8	105.3	90.1	91.3	97.2	99.0	93.0	96.6	104.0	104.0
51	18	77.1	89.6	94.3	94.7	100.2	95.5	95.8	98.1	90.6	91.6	95.9	97.7	95.3	96.4	100.2	100.2
Average	15	84.9	94.0	99.4	99.6	103.7	101.5	101.7	104.2	95.9	96.4	100.2	102.0	98.9	99.6	104.0	104.0
Microphone position 6																	
15	3	106.5	111.2	118.5	119.3	119.8	119.4	119.5	120.2	108.1	108.5	109.7	111.5	111.6	111.5	113.5	113.5
18	3	105.6	110.8	118.2	118.8	120.1	118.8	119.1	120.1	107.9	108.5	109.4	111.2	111.2	112.5	113.1	113.1
21	2	107.2	112.2	119.8	120.7	121.6	120.0	121.0	121.9	108.2	108.8	109.8	111.6	112.0	112.9	113.8	113.8
23	2	103.6	109.5	116.6	116.6	119.6	116.8	116.8	119.5	106.0	106.0	108.7	110.5	108.8	108.8	110.8	110.8
25	3	102.1	107.8	114.7	114.7	117.0	115.3	115.3	117.1	105.2	105.2	107.1	108.9	108.4	108.4	110.1	110.1
39	3	101.9	107.6	114.6	115.0	117.0	115.3	115.7	117.4	104.9	105.0	107.0	108.8	108.3	108.0	110.0	110.0
40	2	103.2	109.0	116.2	117.0	118.8	116.4	117.3	118.7	105.4	105.9	107.8	109.6	108.4	109.2	111.0	111.0
41	3	102.7	108.4	115.5	115.5	118.6	115.9	115.9	118.6	105.4	105.4	108.2	110.0	108.5	108.5	110.8	110.8
43	3	102.1	107.6	114.1	115.3	117.3	114.7	115.9	117.1	104.8	105.2	107.6	109.4	107.8	108.3	110.3	110.3
44	4	100.0	105.6	112.6	112.6	115.5	112.8	112.8	115.3	103.6	103.7	106.4	108.2	106.8	106.8	109.2	109.2
51	3	103.0	109.0	116.2	116.2	119.3	116.4	116.5	119.3	106.4	106.6	109.1	110.8	109.9	109.9	111.5	111.5
Average	3	103.4	109.0	116.1	116.5	118.7	116.5	116.9	118.7	106.0	106.3	108.3	110.1	109.2	109.5	111.3	111.3

TABLE VI.- SUMMARY OF SUBJECTIVE NOISE MEASUREMENTS OBTAINED ON TAKE-OFF—CLIMBOUT OPERATION OF STOL AIRPLANE – Concluded

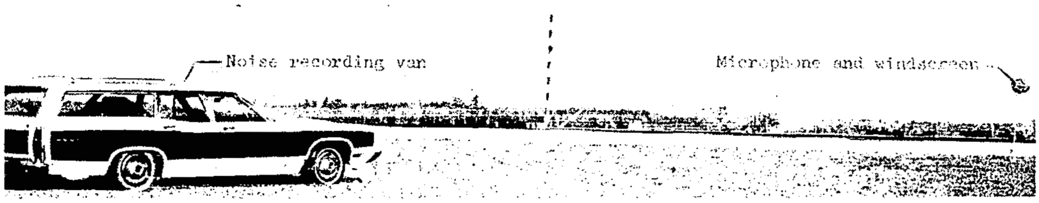
Flight	d_{av}, sec	Max. dB(A)	Max. dB(N)	Max. PNdB	Max. $PNdB_{t1}$	Max. $PNdB_{t2}$	Peak PNdB	Peak $PNdB_{t1}$	Peak $PNdB_{t2}$	EPNdB	$EPNdB_{t1}$	$EPNdB_{t2}$	EPNL(FAA)	EEPNdB	$EEPNdB_{t1}$	$EEPNdB_{t2}$	EPNL(FAA)(app)
Microphone position 7																	
15	3	105.7	110.8	117.6	117.7	120.3	118.0	118.1	120.4	107.4	107.6	109.7	111.5	110.6	110.7	111.6	111.6
18	3	102.7	108.1	115.0	115.0	118.3	115.8	115.8	118.5	105.5	105.7	108.5	110.3	108.7	108.7	111.3	111.3
21	3	103.5	109.0	115.8	117.0	118.9	116.0	116.8	118.8	105.9	106.7	108.8	110.6	108.8	110.0	111.9	111.9
23	4	100.1	105.0	111.8	111.8	113.1	112.5	112.5	113.6	103.2	103.4	104.9	106.7	106.6	106.6	107.9	107.9
25	6	98.2	102.6	109.2	109.4	111.1	110.0	110.0	111.3	102.4	102.4	104.5	106.3	105.9	105.8	107.8	107.8
39	4	99.9	106.3	112.9	113.1	116.2	113.7	113.9	116.5	104.4	105.2	107.5	109.3	107.7	108.4	110.5	110.5
40	5	98.5	103.9	110.8	110.8	113.1	111.5	111.5	113.2	103.2	103.2	105.5	107.3	106.0	106.0	108.3	108.3
41	5	98.0	104.0	110.8	110.8	113.1	111.3	111.3	113.3	102.9	103.1	105.4	107.2	106.1	106.5	108.5	108.5
43	5	99.9	105.4	112.1	112.6	114.5	112.8	112.8	114.6	104.2	104.7	106.5	108.3	107.4	108.3	109.5	109.7
44	7	97.3	101.7	107.9	107.9	110.7	109.7	109.7	110.9	101.8	102.0	104.2	106.0	104.9	104.9	107.4	107.4
51	5	105.8	110.3	116.6	116.6	118.5	117.3	117.4	118.9	108.9	109.3	110.8	112.6	112.3	112.3	114.2	114.2
Average	5	100.8	106.1	112.8	112.9	115.3	113.5	113.6	115.5	104.5	104.8	106.9	108.7	107.7	108.0	109.9	109.9
Microphone position 8																	
15	6	99.5	104.1	110.2	111.3	112.5	111.1	111.7	112.8	103.3	103.9	105.7	107.5	106.3	107.0	108.5	108.5
18	7	97.0	101.6	108.3	108.4	110.4	109.3	109.3	111.1	102.1	102.3	104.2	106.0	105.3	105.4	107.4	107.4
21	5	100.2	105.3	111.6	112.0	113.9	112.5	112.5	114.1	103.7	104.1	105.8	107.6	107.3	107.7	109.5	109.5
23	7	96.7	102.0	108.0	108.0	110.3	108.9	108.9	110.5	101.3	101.5	103.6	105.4	104.3	104.7	106.7	106.7
25	9	94.0	99.4	105.7	106.4	108.6	106.9	107.3	108.6	100.8	101.2	103.1	104.9	103.5	104.2	106.1	106.1
39	8	96.8	101.0	106.6	106.6	108.1	107.4	107.4	108.6	100.3	100.5	102.1	103.9	103.5	103.8	105.4	105.4
40	8	94.4	99.0	105.0	105.4	107.4	106.6	106.6	107.7	99.7	100.2	102.1	103.9	102.5	102.9	104.9	104.9
41	9	93.7	98.3	104.6	104.6	107.0	105.8	105.8	107.6	99.1	99.5	101.7	103.5	102.4	102.9	105.2	105.2
43	10	92.4	97.6	104.2	105.0	107.1	105.5	105.6	108.3	99.6	100.4	102.1	103.9	102.7	103.9	105.3	105.3
44	9	95.4	99.7	105.3	105.3	107.6	105.8	105.9	107.4	99.1	99.5	101.5	103.3	103.1	103.7	105.1	105.1
51	11	92.3	97.8	104.9	105.0	107.3	105.5	105.5	107.1	99.2	99.6	101.3	103.1	103.4	103.5	105.1	105.1
Average	8	95.7	100.5	106.8	107.1	109.1	107.8	107.9	109.4	100.7	101.2	103.0	104.8	104.0	104.5	106.3	106.3
Microphone position 9																	
15	8	93.5	99.6	106.2	106.4	108.7	107.4	107.4	109.2	100.4	100.9	102.8	104.6	103.5	103.7	105.7	105.7
18	11	91.4	96.8	103.8	104.0	106.7	105.2	105.3	107.2	99.1	99.6	101.7	103.5	102.4	102.5	104.8	104.8
21	10	94.7	99.5	105.8	106.3	108.7	107.6	107.7	109.5	101.2	101.6	103.6	105.4	104.2	104.9	106.9	106.9
23	11	92.0	98.2	104.6	104.6	107.3	105.6	105.6	107.1	99.4	99.5	101.9	103.7	103.5	103.7	105.7	105.7
25	13	90.4	96.1	101.9	103.4	104.1	104.0	104.0	105.7	98.5	99.1	100.7	102.5	101.5	102.8	103.7	103.7
39	10	90.2	95.5	102.5	103.0	104.7	103.5	103.6	105.2	97.4	97.8	99.8	101.6	100.7	101.5	103.0	103.0
40	11	89.3	95.2	102.0	103.1	104.8	103.6	103.6	105.8	98.1	98.6	100.6	102.4	101.0	101.6	103.3	103.3
41	11	89.9	96.1	102.4	103.4	104.7	103.6	103.6	105.2	98.0	98.6	100.4	102.2	101.2	102.3	103.5	103.5
43	12	89.6	96.0	102.2	103.5	104.5	103.7	103.7	105.4	97.9	98.4	100.0	101.8	101.5	102.6	103.7	103.7
44	11	89.3	94.2	101.2	101.2	103.2	102.4	102.4	103.9	96.2	96.6	98.3	100.1	99.8	100.0	101.7	101.7
51	14	88.9	94.3	100.9	100.9	103.6	102.2	102.2	103.9	97.6	97.9	100.0	101.8	100.7	100.7	102.9	102.9
Average	11	90.8	96.5	103.0	103.6	105.5	104.4	104.5	106.2	98.5	99.0	100.9	102.7	101.8	102.4	104.1	104.1
Microphone position 10																	
15	9	92.8	98.8	104.9	105.5	107.1	105.4	105.4	107.0	98.6	99.2	101.0	102.8	102.9	103.5	105.1	105.1
18	11	90.9	96.4	102.4	102.5	104.9	103.9	104.0	106.1	98.2	98.6	100.7	102.5	101.2	101.3	103.6	103.6
21	11	90.7	96.4	102.8	103.5	105.2	103.8	103.8	105.9	98.3	98.2	100.7	102.5	101.8	102.3	104.0	104.0
23	12	89.4	94.7	100.6	100.7	104.1	102.0	102.0	104.4	96.8	97.4	99.6	101.4	100.0	100.3	103.5	103.5
25	13	88.4	93.7	99.9	100.1	102.9	100.8	100.9	102.6	96.3	96.9	98.9	100.7	99.6	100.1	102.4	102.4
39	13	89.7	95.1	101.3	101.3	104.0	102.6	102.6	105.4	97.4	97.6	100.0	101.8	100.8	100.5	103.0	103.0
40	13	88.7	94.0	100.4	100.9	102.9	102.0	102.0	103.8	97.0	97.5	99.4	101.2	100.1	100.6	102.3	102.3
41	13	88.9	94.6	100.7	100.8	103.5	101.9	101.9	103.6	97.0	97.6	99.3	101.1	100.4	100.8	103.2	103.2
43	14	88.3	94.2	100.0	101.5	102.0	101.0	101.3	102.8	96.2	96.9	98.5	100.3	99.8	101.4	102.1	102.1
44	15	87.5	92.5	99.1	99.2	101.4	100.2	100.2	101.7	96.0	96.5	98.1	99.9	99.2	99.6	101.4	101.4
51	15	87.8	93.4	99.5	99.6	102.1	100.9	100.9	103.1	96.6	96.9	99.1	100.9	99.6	99.7	102.1	102.1
Average	13	89.4	94.9	101.1	101.4	103.6	102.2	102.3	104.2	97.1	97.6	99.6	101.4	100.5	100.9	103.0	103.0

TABLE VII.- SUMMARY OF SUBJECTIVE NOISE MEASUREMENTS OBTAINED ON FLYBY OPERATION OF STOL AIRPLANE

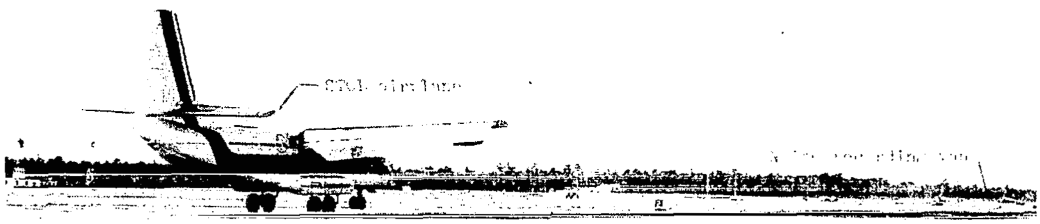
[Microphone position 6]

Flight	d_{av}, sec	Max. dB(A)	Max. dB(N)	Max. PNdB	Max. $PNdB_{t1}$	Max. $PNdB_{t2}$	Peak PNdB	Peak $PNdB_{t1}$	Peak $PNdB_{t2}$	EPNdB	$EPNdB_{t1}$	$EPNdB_{t2}$	EPNL(FAA)	EEPNdB	$EEPNdB_{t1}$	$EEPNdB_{t2}$	EPNL(FAA)(app)
101	17	76.9	83.0	89.2	89.3	92.0	91.0	91.0	94.0	86.4	86.8	88.9	90.7	89.6	90.0	92.2	92.2
102	15	77.3	83.9	89.8	90.8	92.3	91.5	91.5	93.9	86.0	86.4	88.4	90.2	89.5	90.3	92.0	92.0
Average	16	77.1	83.5	89.5	90.0	92.2	91.3	91.3	94.0	86.3	86.6	88.7	90.5	89.6	90.2	92.1	92.1
103	8	84.9	90.6	97.3	97.3	99.2	98.4	98.4	100.2	91.2	91.4	93.3	95.1	94.3	94.3	96.2	96.2
104	6	85.5	91.9	98.5	98.8	100.8	99.4	100.3	101.5	91.1	91.3	93.2	95.0	94.6	94.8	96.4	96.4
Average	7	85.2	91.2	97.9	98.1	100.0	98.9	99.4	100.9	91.2	91.4	93.3	95.1	94.5	94.6	96.3	96.3
105	5	92.0	97.2	104.6	104.6	105.9	105.1	105.1	106.3	95.8	96.2	97.2	99.0	98.8	99.3	100.7	100.7
106	4	93.0	98.4	105.7	105.7	107.0	106.2	106.2	107.5	96.3	96.3	97.6	99.4	100.0	100.0	101.2	101.2
Average	4.5	92.5	97.8	105.2	105.2	106.5	105.7	105.7	106.9	96.1	96.3	97.4	99.2	99.4	99.7	101.0	101.0
107	8	86.7	91.9	98.8	98.8	100.6	99.9	99.9	101.4	92.7	92.8	94.6	96.4	95.7	95.7	97.6	97.6
108	7	87.0	92.4	99.3	99.3	101.3	100.1	100.1	102.0	92.7	92.8	94.6	96.4	96.0	96.0	98.0	98.0
Average	7.5	86.8	92.2	99.1	99.1	101.0	100.0	100.0	101.7	92.7	92.8	94.6	96.4	95.9	95.9	97.8	97.8

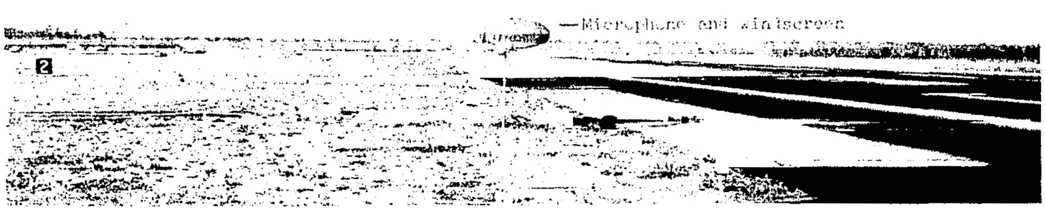
(a) View looking south.



(b) View looking west.



(c) View looking east.



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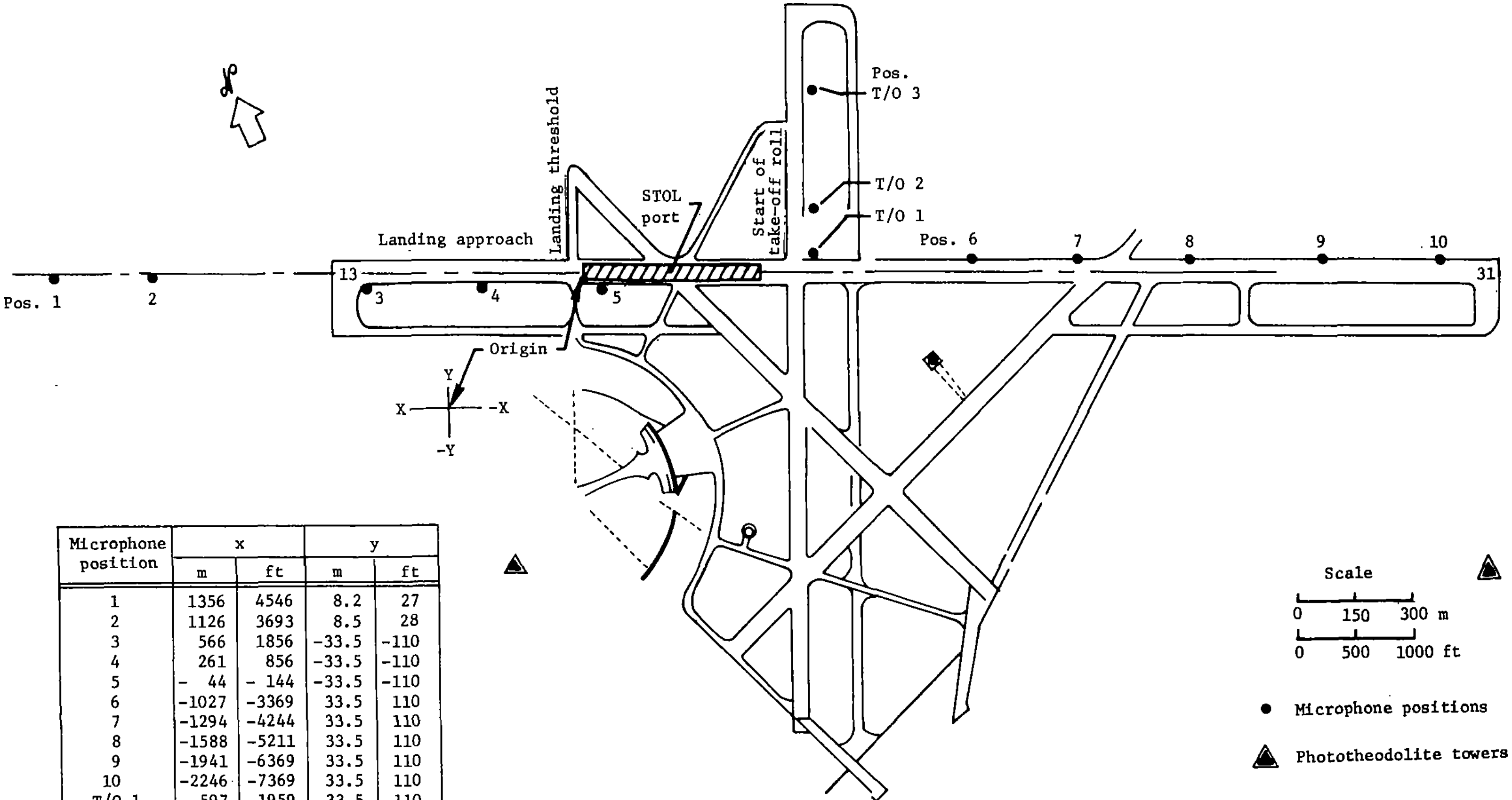
(d) View looking southeast.

Figure 1.- Photographs of NAFEC test area showing STOL airplane and noise measuring station.



Microphone position	x		y	
	m	ft	m	ft
1	1356	4546	8.2	27
2	1126	3693	8.5	28
3	566	1856	-33.5	-110
4	261	856	-33.5	-110
5	- 44	- 144	-33.5	-110
6	-1027	-3369	33.5	110
7	-1294	-4244	33.5	110
8	-1588	-5211	33.5	110
9	-1941	-6369	33.5	110
10	-2246	-7369	33.5	110
T/O 1	- 597	-1959	33.5	110
T/O 2	- 597	-1959	152	500
T/O 3	- 597	-1959	457	1500

Figure 2.- Plan-view sketch of NAFEC test area showing noise measuring positions with respect to STOL port and airplane flight track.

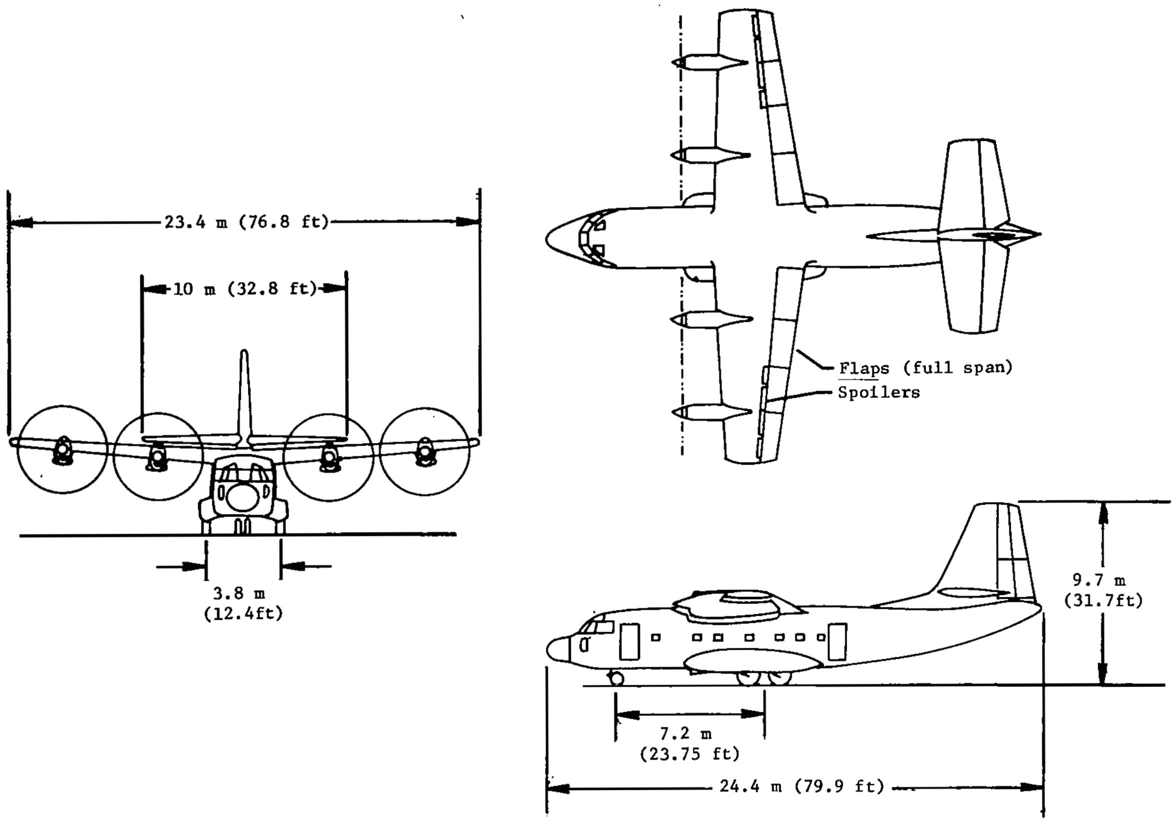


Figure 3.- Three-view drawing of four-engine turbopropeller STOL airplane.

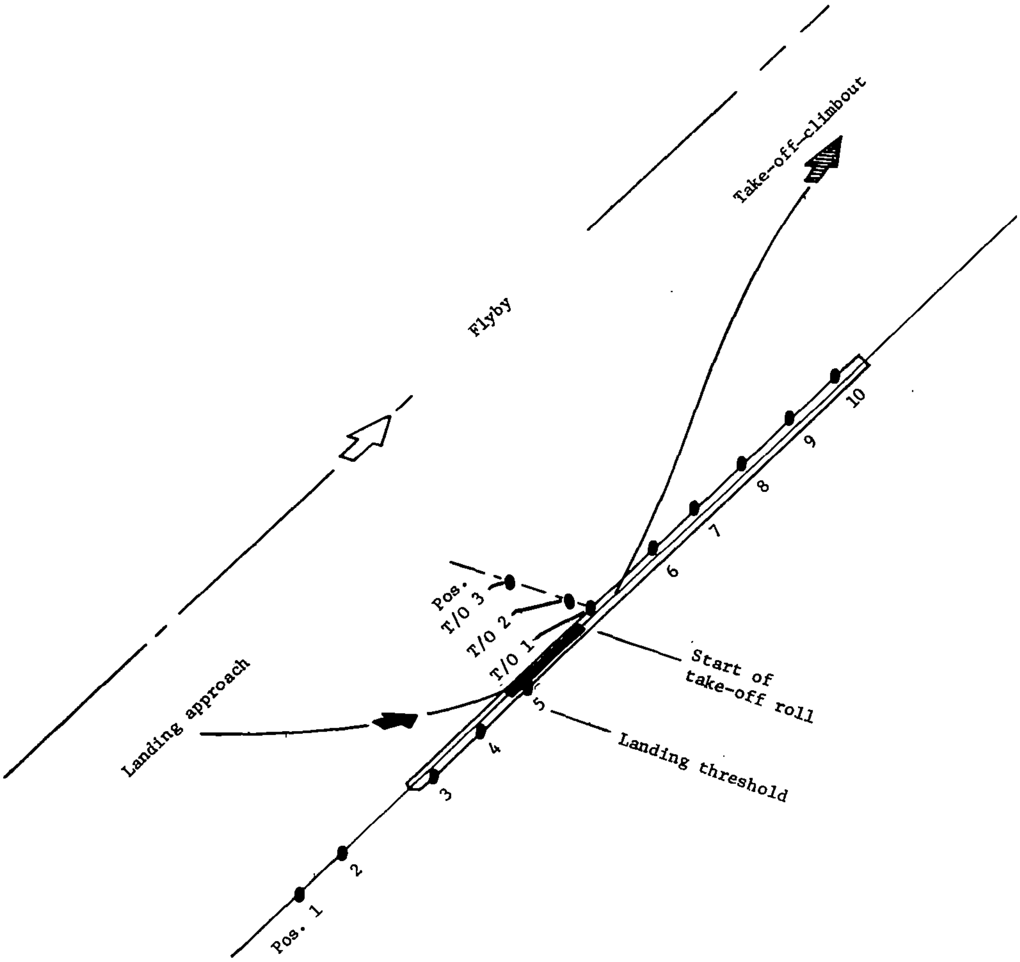


Figure 4.- Diagram of flight operations showing touchdown and take-off points and microphone positions (solid symbols).

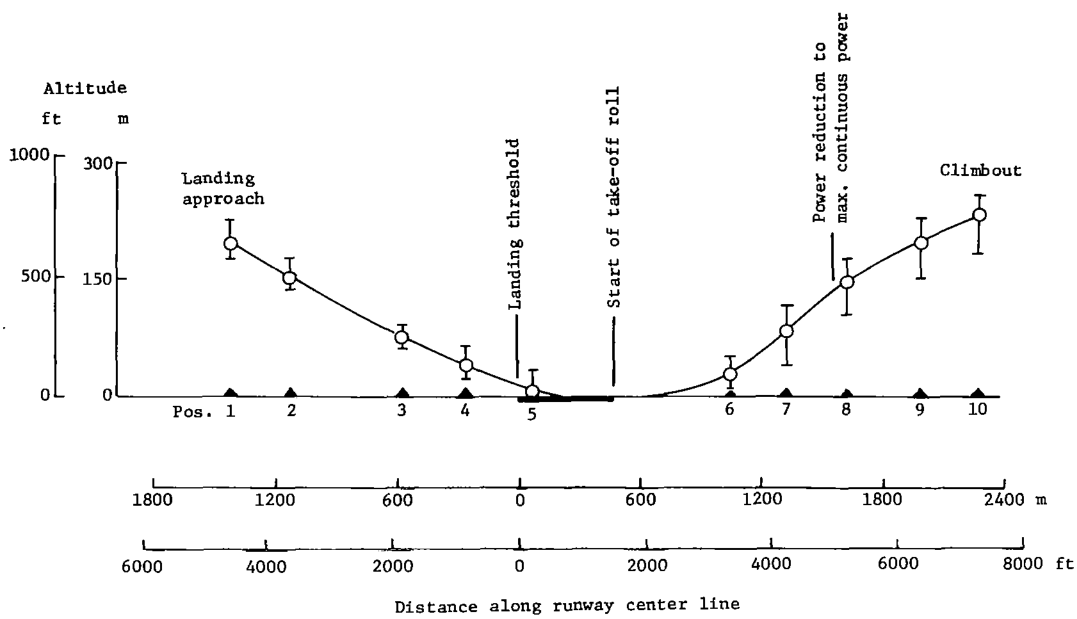
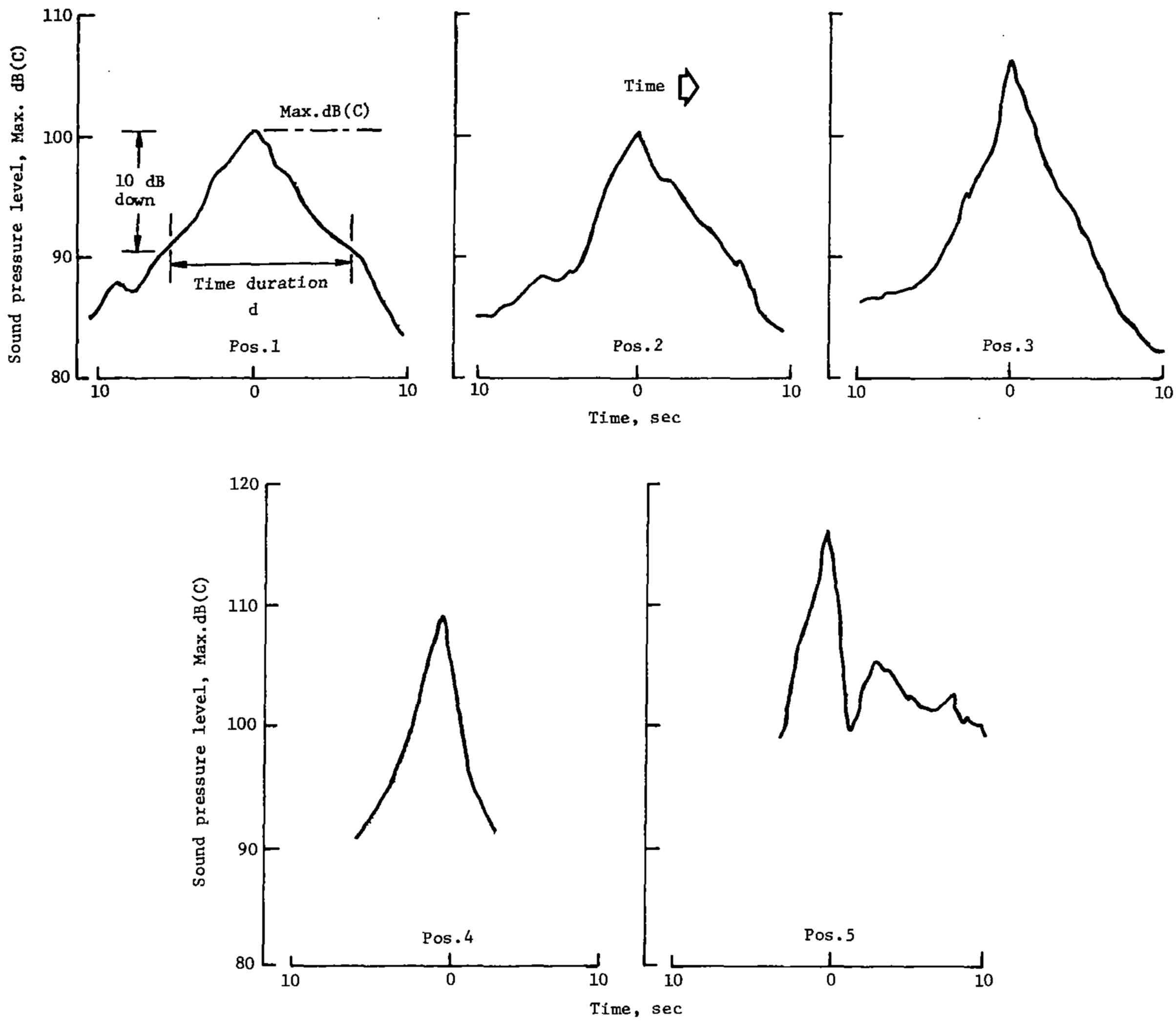
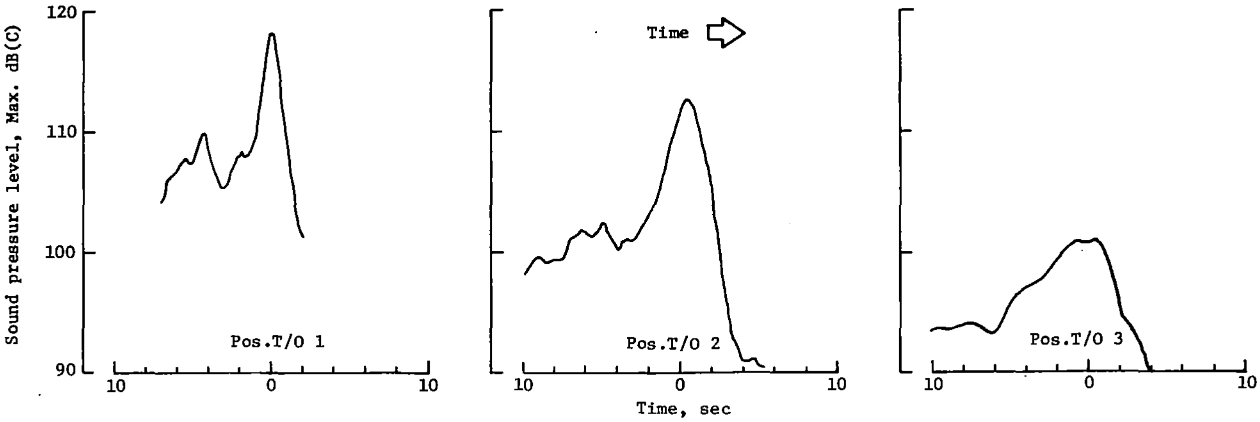


Figure 5.- Altitude-distance profiles for landing-approach and take-off—climbout operations of all noise flights. (Circle symbols indicate average altitude at each position, and vertical bars represent range of altitudes flown.)

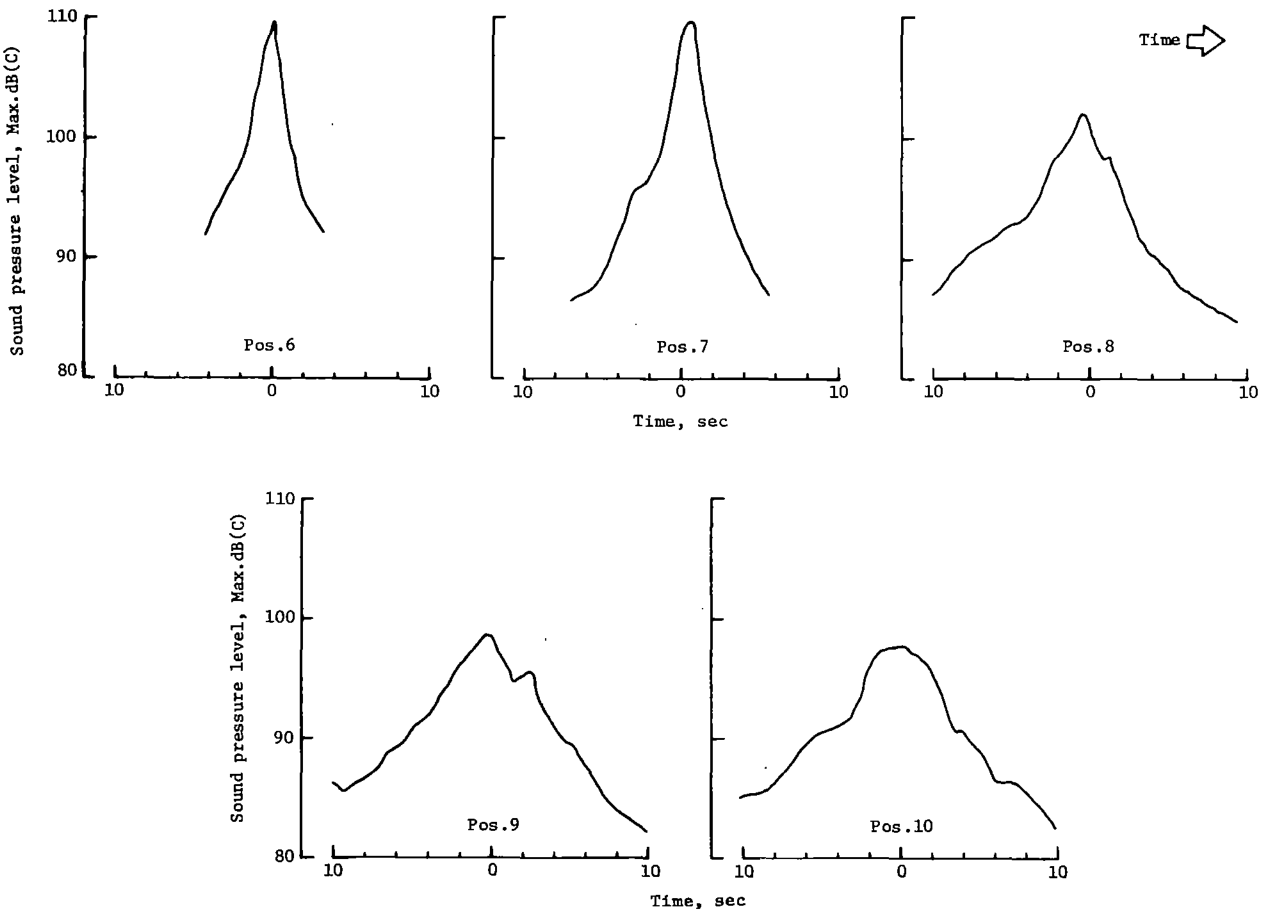


(a) Landing approach (flight 9).

Figure 6.- Typical time histories of noise measured at various ground stations during operation of STOL airplane.

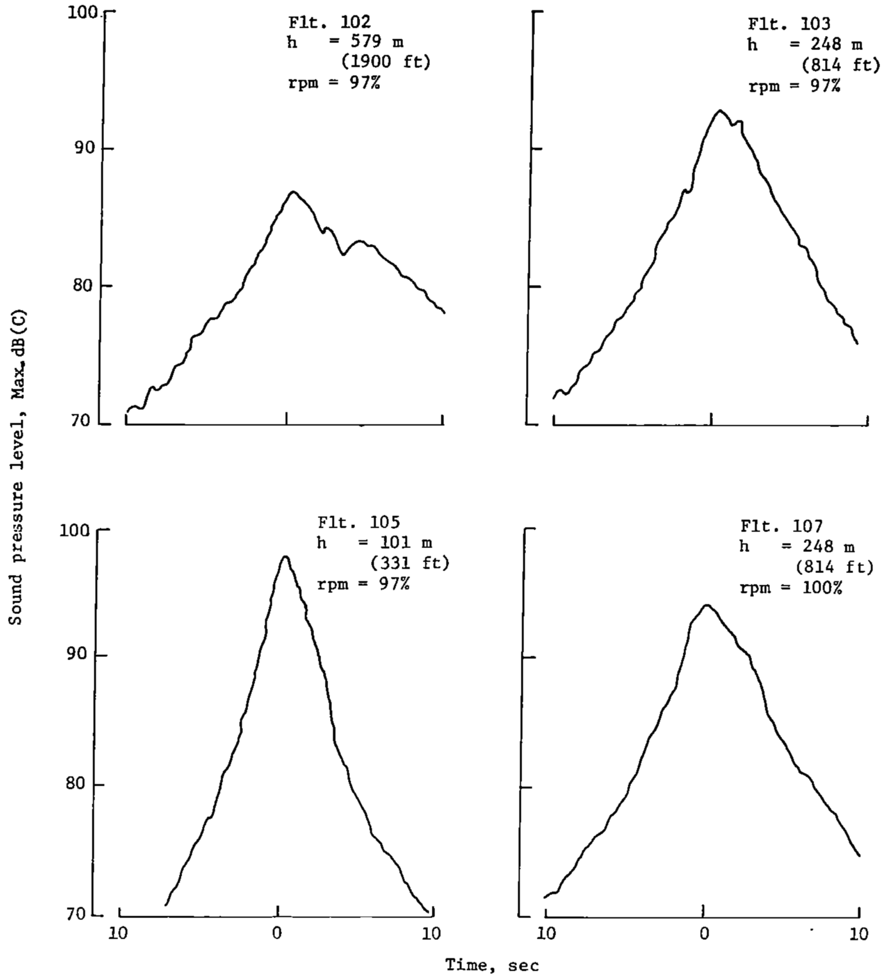


(b) Take-off (flight 39).



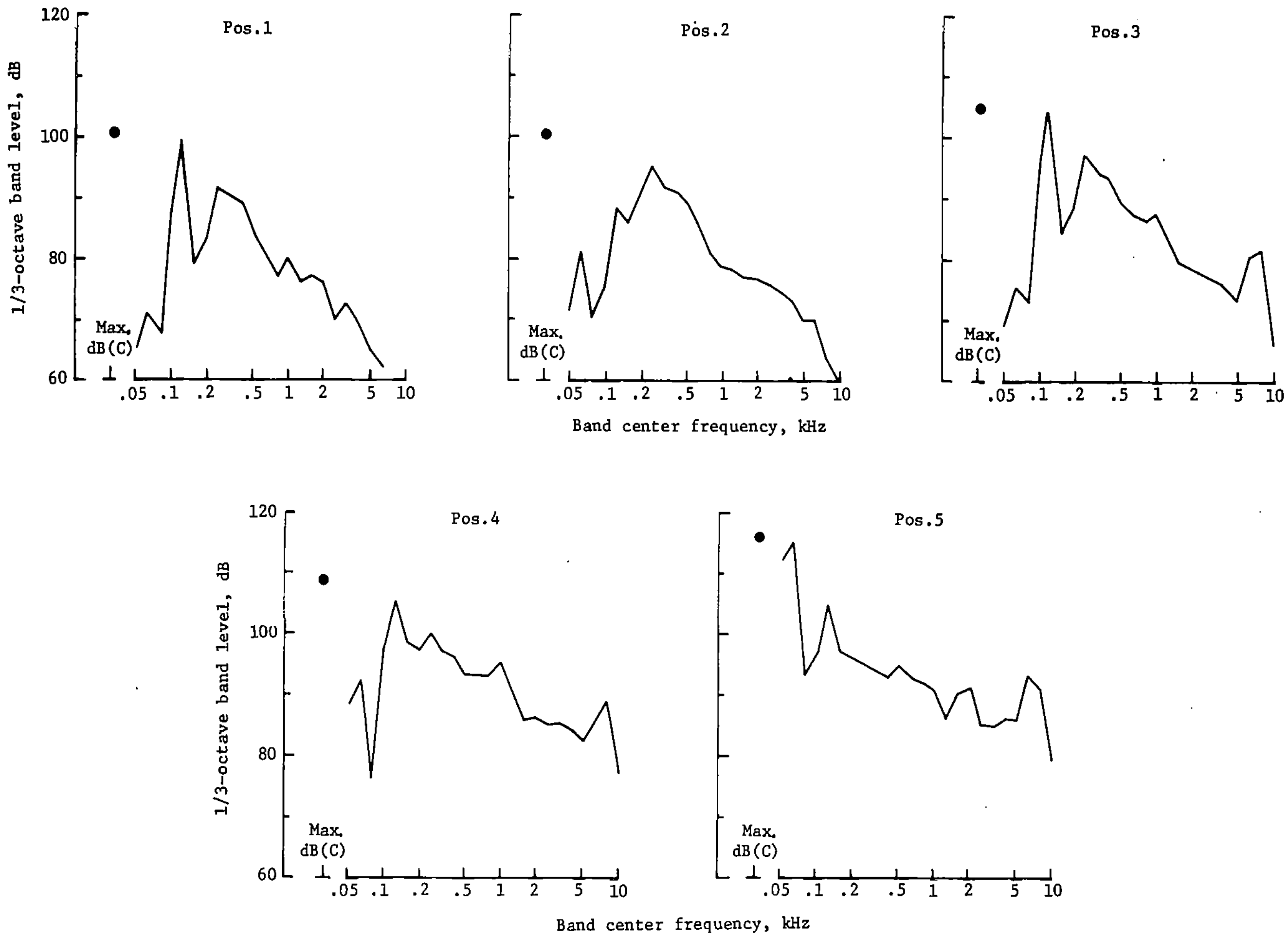
(c) Climbout (flight 39).

Figure 6.- Continued.



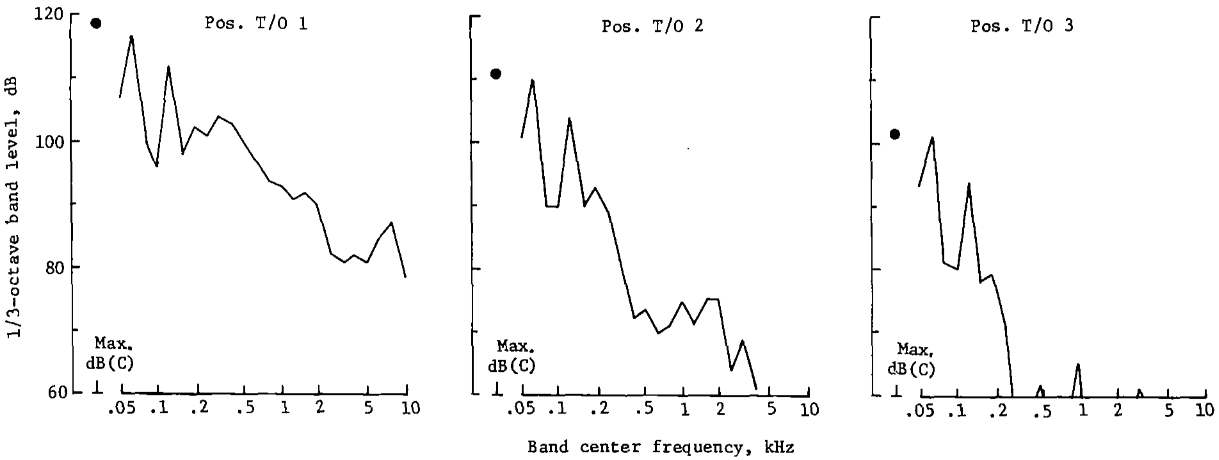
(d) Flyby. Microphone position 6.

Figure 6.- Concluded.



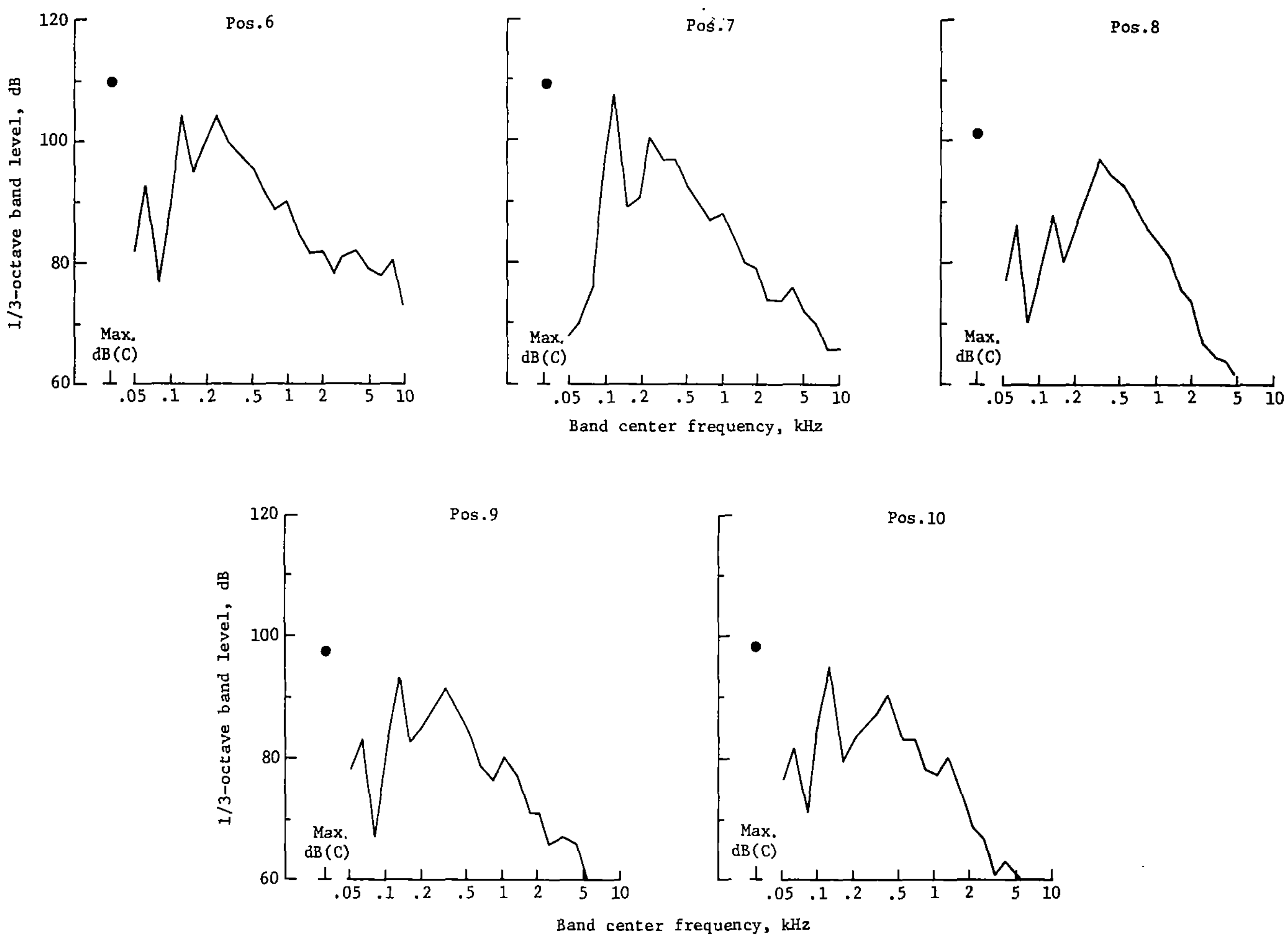
(a) Landing approach (flight 9).

Figure 7.- 1/3-octave band spectra at time of occurrence of Max. dB(C) as measured at various microphone positions and for various flights.



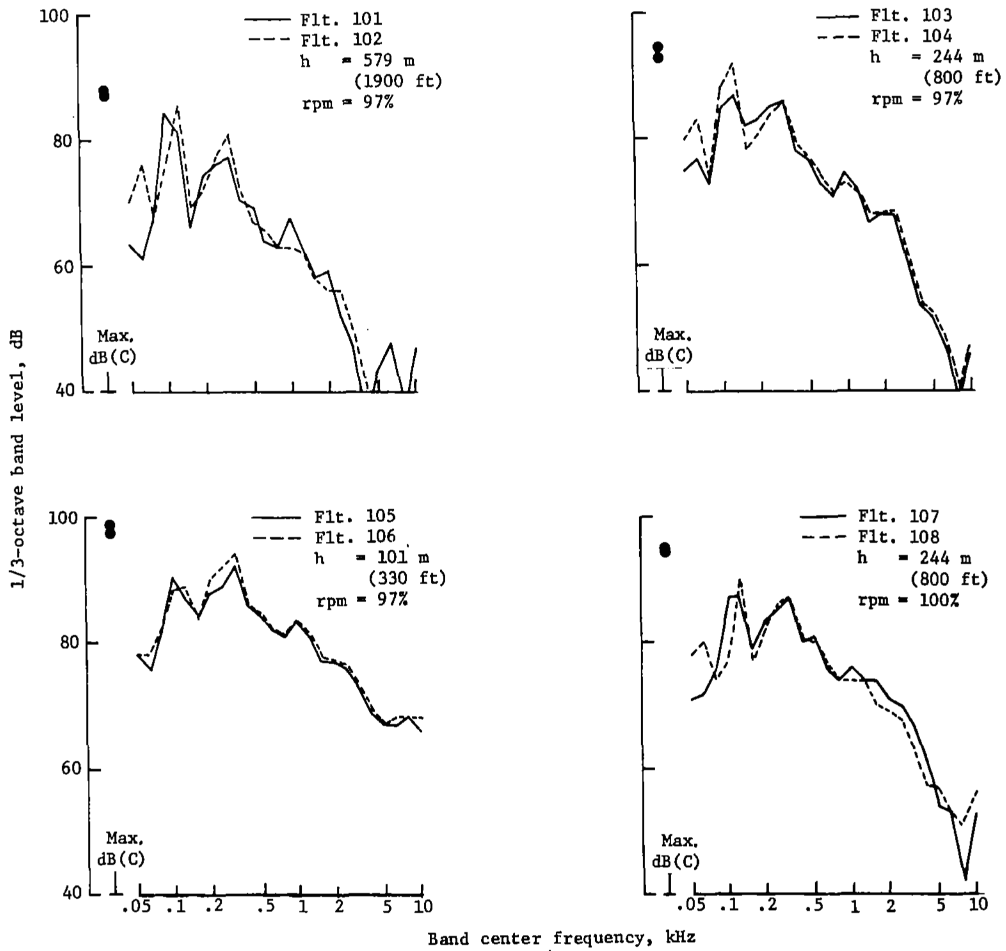
(b) Take-off (flight 39).

Figure 7.- Continued.



(c) Climbout (flight 39).

Figure 7.- Continued.



(d) Flyby. Microphone position 6.

Figure 7.- Concluded.

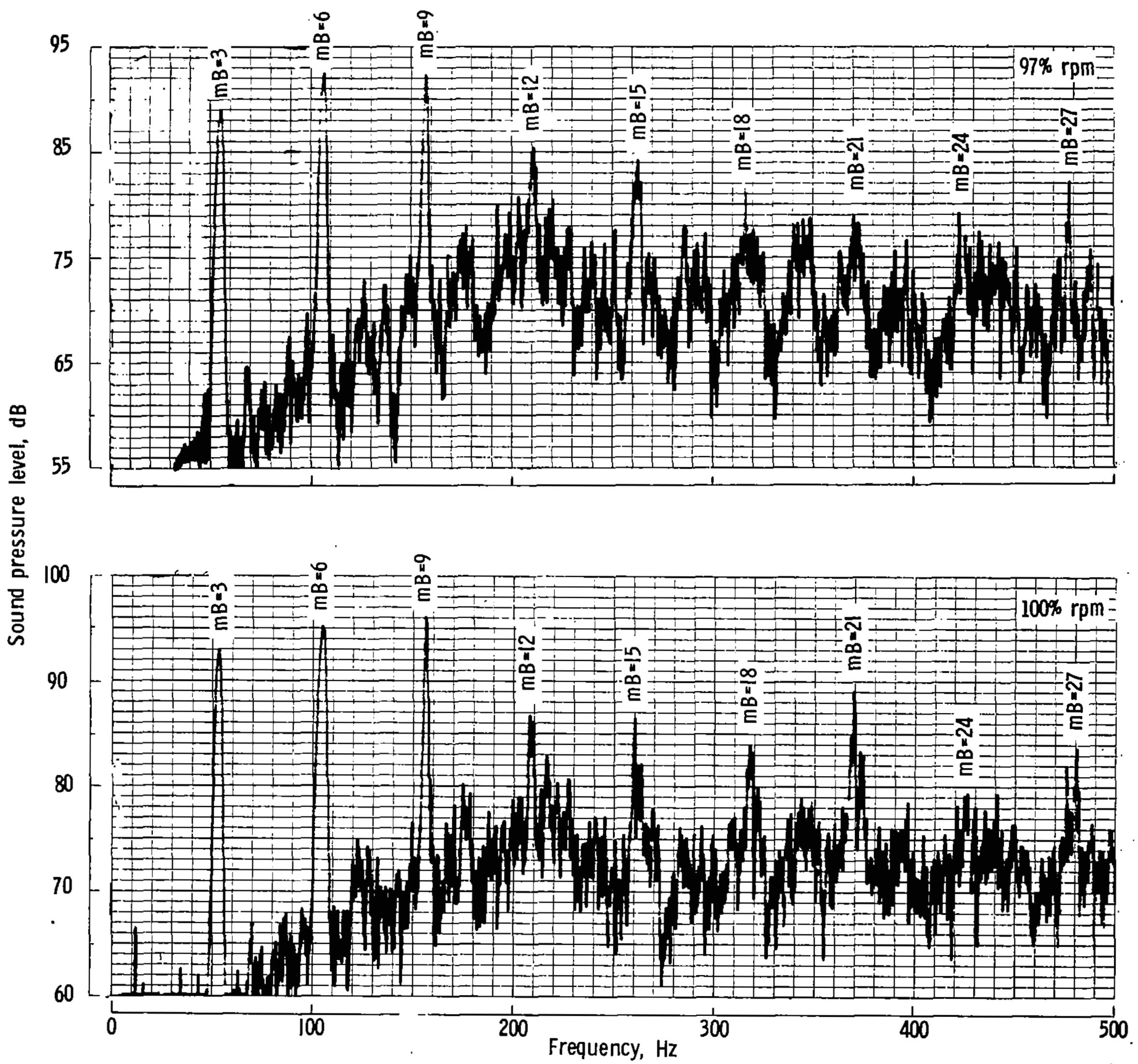
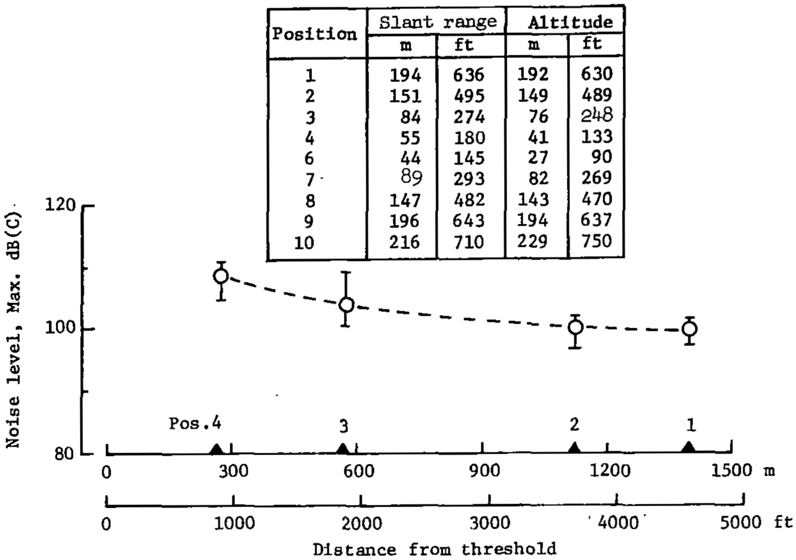
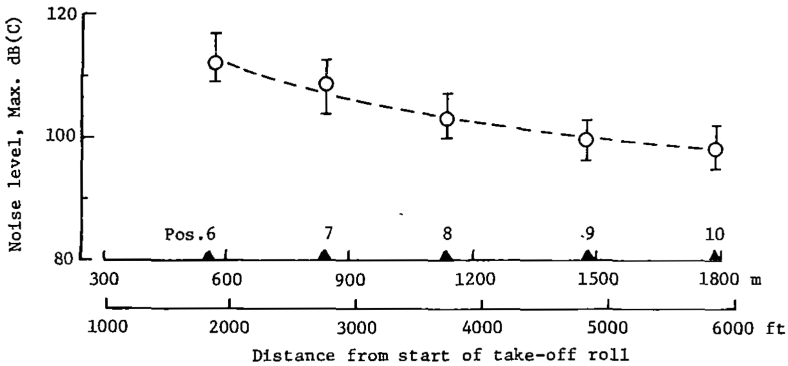


Figure 8.- Narrow-band spectra of noise produced by No. 4 engine of STOL airplane during static operations. The microphone was located in the plane of the propeller at a distance of 61 m (200 ft).



Position	Slant range		Altitude	
	m	ft	m	ft
1	194	636	192	630
2	151	495	149	489
3	84	274	76	248
4	55	180	41	133
6	44	145	27	90
7	89	293	82	269
8	147	482	143	470
9	196	643	194	637
10	216	710	229	750

(a) Landing approach.



(b) Take-off—climbout.

Figure 9.- Noise levels as measured along the ground track of STOL airplane during landing-approach and take-off—climbout operations. (Circle symbols indicate average noise levels, and the vertical bars represent range of values encountered.)

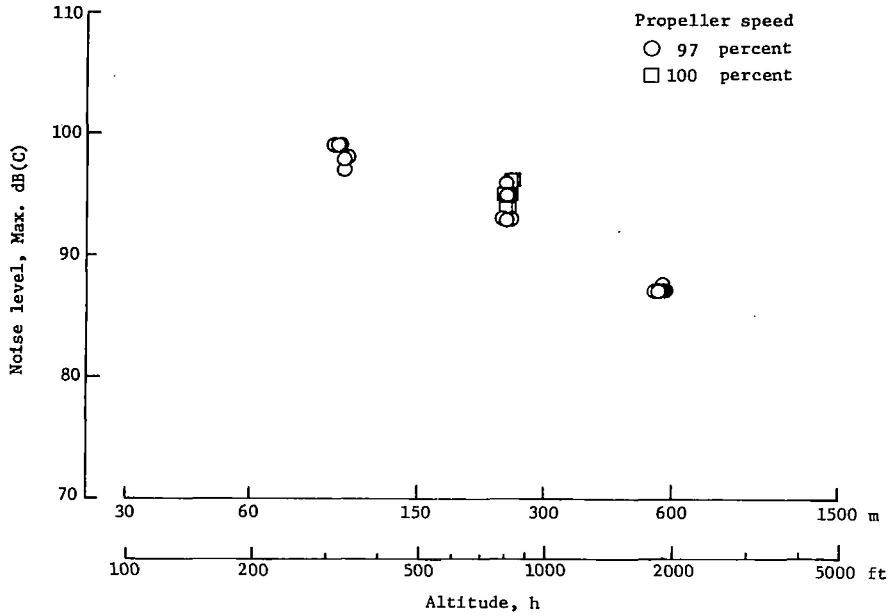


Figure 10.- Noise levels measured at microphone position 6 for two power conditions during constant-altitude flyby of STOL airplane.

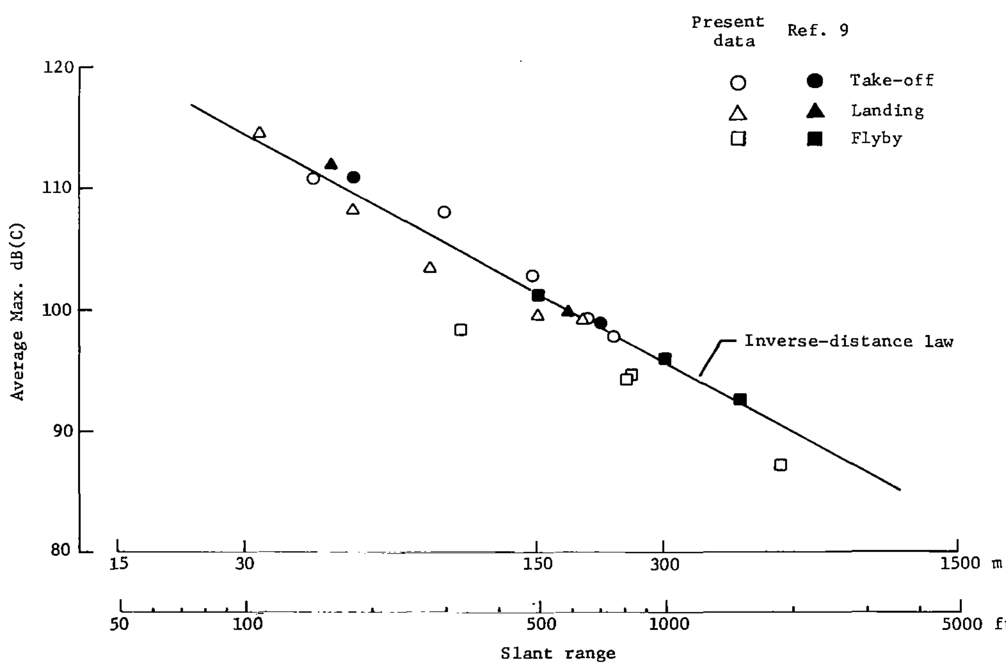


Figure 11.- Average noise levels for STOL airplane during take-off—climbout, landing-approach, and flyby operations.

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