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(1) U.S. Department of Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142
(2) ORI, Inc. 1375 Piccard Drive, Rockville, Maryland 20850

16. Abstract
This report documents the results of a Federal Aviation Administration (FAA) noise measurement flight test program with the Sikorsky S-76 helicopter. The report contains documentary sections describing the acoustical characteristics of the subject helicopter and provides analyses and discussions addressing topics ranging from acoustical propagation to environmental impact pf helicopter noise.

This report is the sixth in a series of seven documenting the FAA helicopter noise measurement program conducted at Dulles International Airport during the summer of 1983. The S-76 test program involved the acquistion of detailed acoustical, position and meteorological data.

This test program was designed to address a series of objectives including: 1) acquisition of acoustical data for use in assesing heliport environment impact, 2) documentation of directivity characteristics for static operation of helicopters, 3) establishment of ground-to-ground and air-to-ground acoustical propagation relationships for helicopters, 4) determination of noise event duration influences on energy dose acoustical metrics, 5) examination of the differences between noise measured by a surface mounted microphone and a microphone mounted at a height of four feet (1.2 meters), and 6) documentation of noise levels aquired using international helicopter noise certification test procedures.

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SIKORSKY S-76A HELICOPTER

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GLOSSARY

AGL	–	Above ground level
AIR	–	Aerospace Information Report
AL	–	A-Weighted sound level, expressed in decibels (See L_A)
AL_M	–	Maximum A-weighted sound level, expressed in decibels (see L_{AM})
AL_{AM}	–	As measured maximum A-weighted Sound Level
ALT	–	Aircraft altitude above the microphone location
APP	–	Approach operational mode
CLC	–	Centerline Center
CPA	–	Closest point of approach
d	–	Distance
dB	–	Decibel
dBA	–	A-Weighted sound level expressed in units of decibels (see A_L)
df	–	Degree of freedom
Δ	–	Delta, or change in value
$\Delta 1$	–	Correction term obtained by correcting SPL values for atmospheric absorption and flight track deviations per FAR 36, Amendment 9, Appendix A, Section A36.11, Paragraph d
$\Delta 2$	–	Correction term accounting for changes in event duration with deviations from the reference flight path
DUR(A)	–	"10 dB-Down" duration of L_A time history
EPNL	–	Effective perceived noise level (symbol is LEPN)
EV	–	Event, test run number

FAA	-	Federal Aviation Administration
FAR	-	Federal Aviation Regulation
FAR-36	-	Federal Aviation Regulation, Part 36
GLR	-	Graphic level recorder
HIGE	-	Hover-in-ground effect
HOGE	-	Hover-out-of-ground effect
IAS	-	Indicated airspeed
ICAO	-	International Civil Aviation Organization
IRIG-B	-	Inter-Range Instrumentation Group B (established technical time code standard)
J	-	The value which determines the radiation pattern
K(DUR)	-	The constant used to correct SEL for distance and velocity duration effects in $\Delta 2$
KIAS	-	Knots Indicated Air Speed
K(P)	-	Propagation constant describing the change in noise level with distance
K(S)	-	Propagation constant describing the change in SEL with distance
Kts	-	Knots
L_A	-	A-Weighted sound level, expressed in decibels
Leq	-	Equivalent sound level
LFO	-	Level Flyover operational mode
M_A	-	Advancing blade tip Mach number
M_R	-	Rotational Mach number
M_T	-	Translational Mach number
N	-	Sample size
NWS	-	National Weather Service
$OASPL_M$	-	Maximum overall sound pressure level in decibels

PISLM	-	Precision integrating sound level meter
PNL_M	-	Maximum perceived noise level
$PNLT_M$	-	Maximum tone corrected perceived noise level
POP	-	Photo overhead positioning system
Q	-	Time history "shape factor"
RH	-	Relative Humidity in percent
RPM	-	Revolutions per minute
SAE	-	Society of Automotive Engineers
SEL	-	Sound exposure level expressed in decibels. The integration of the AL time history, normalized to one second (symbol is L_{AE})
SEL_{AM}	-	As measured sound exposure level
$SEL-AL_M$	-	Duration correction factor
SHP	-	Shaft horse power
SLR	-	Single lens reflex (35 mm camera)
SPL	-	Sound pressure level
T	-	Ten dB down duration time
TC	-	Tone correction calcualted at $PNLT_M$
T/O	-	Takeoff
TSC	-	Department of Transportation, Transportation Systems Center
V	-	Velocity
VASI	-	Visual Approach Slope Indicator
V_H	-	Maximum speed in level flight with maximum continuous power
V_{NE}	-	Never-exceed speed
Vy	-	Velocity for best rate of climb

1.0 Introduction - This report documents the results of a Federal Aviation Administration (FAA) noise measurement/flight test program involving the Sikorsky S-76A helicopter. The report contains documentary sections describing the acoustical characteristics of the subject helicopter and provides analyses and discussions addressing topics ranging from acoustical propagation to environmental impact of helicopter noise.

This report is the sixth in a series of seven documenting the FAA helicopter noise measurement program conducted at Dulles International Airport during the summer of 1983.

The S-76A test program was conducted by the FAA in cooperation with Sikorsky Aircraft and a number of supporting Federal agencies. The rigorously controlled tests involved the acquisition of detailed acoustical, position and meteorological data.

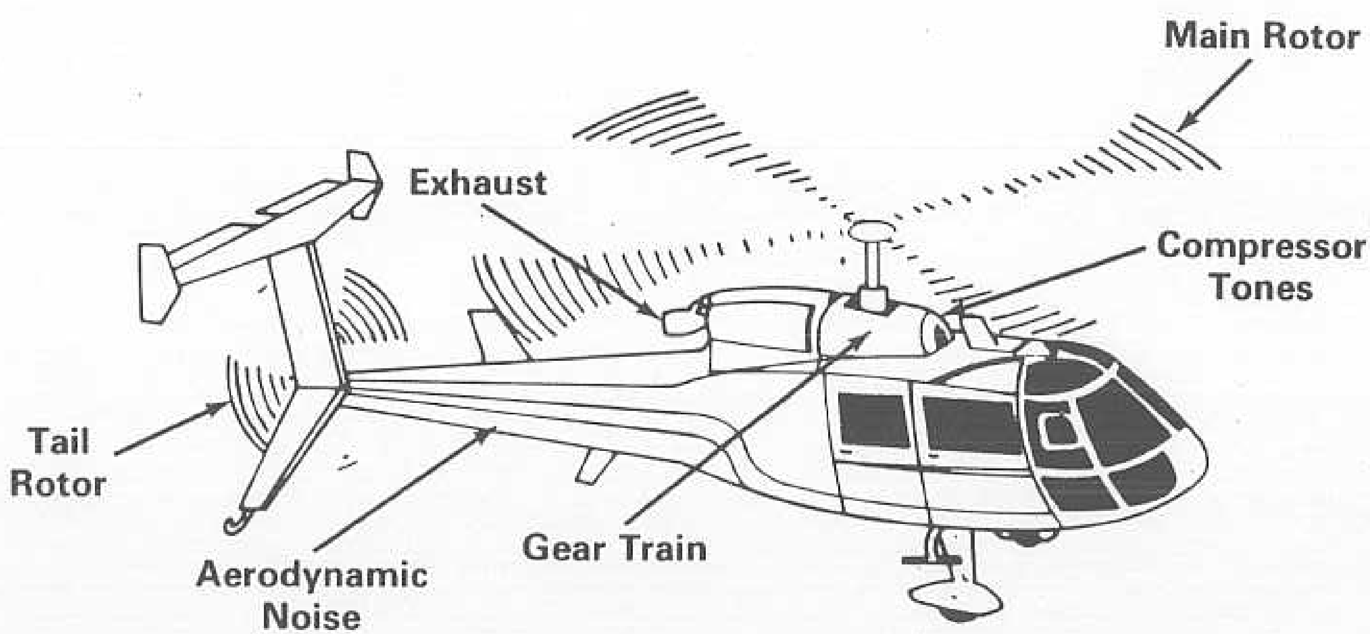
This test program was designed to address a series of objectives including: 1) acquisition of acoustical data for use in heliport environmental impact analyses, 2) documentation of directivity characteristics for static operation of helicopters, (3) establishment of ground-to-ground and air-to-ground acoustical propagation relationships for helicopters, 4) determination of noise event duration influences on energy dose acoustical metrics, 5) examination of the differences between noise measured by a surface mounted microphone and a microphone mounted at a height of four feet (1.2 meters), and 6) documentation of noise levels acquired using international helicopter noise certification test procedures.

The helicopter is an acoustically complex machine which generates noise from many different sources. Figure 1.1 provides a diagram identifying some of these sources. Two other noise generating mechanisms (both associated with flight effects and both producing impulsive noise) are blade vortex interaction (see Figure 9.9) and high advancing tip Mach Numbers. These figures are provided for the reader's reference.

The appendices to this document provide a reference set of acoustical data for the S-76A helicopter operating in a variety of typical flight regimes. The first seven chapters contain the introduction and description of the helicopter, test procedures and test equipment. Chapter 8 describes analyses of flight trajectories and meteorological data and is documentary in nature. Chapter 9 delves into the areas of acoustical propagation, helicopter directivity for static operations, and variability in measured acoustical data over various propagation surfaces. The analyses of Chapter 9 in some cases succeed in establishing relationships characterizing the acoustic nature of the subject helicopter, while in other instances the results are too variant and anomalous to draw any firm conclusions. In any event, all of the analyses provide useful insight to people working in the field of helicopter environmental acoustics, either in providing a tool or by identifying areas which need the illumination of further research efforts.

FIGURE 1.1

Helicopter Noise Sources



2.0 Test Helicopter Description - The Sikorsky S-76A, previously known as simply the Sikorsky S-76, is a twin turbine, general purpose all-weather helicopter designed to meet the needs of the offshore oil support, the corporate executive, and the general utility markets. It is manufactured by Sikorsky Aircraft of Stratford, Connecticut and can accomodate a pilot, a copilot and up to twelve passengers. Various executive/luxury layout are available. Also available are three different medical kits to convert the S-76A to an air medical evacuation system; a single stretcher intensive care unit; or to a three stretcher ambulance.

Selected operational characteristics, obtained from the helicopter manufacturer, are presented in Table 2.1.

Table 2.2 presents a summary of the flight operational reference parameters determined using the procedures specified in the International Civil Aviation Organization (ICAO) noise certification testing requirements. Presented along with the operational parameters are the altitudes that one would expect the helicopter to attain (referred to the ICAO reference test sites). This information is provided so that the reader may implement an ICAO type data correction using the "As Measured" data contained in this report. This report does not undertake such a correction, leaving it as the topic of a subsequent report.

TABLE 2.1

HELICOPTER CHARACTERISTICS

HELICOPTER MANUFACTURER	: Sikorsky Aircraft
HELICOPTER MODEL	: S-76A
HELICOPTER TYPE	: Single Rotor
TEST HELICOPTER N-NUMBER	: N38
MAXIMUM GROSS TAKEOFF WEIGHT	: 10300 lbs (4672 kg)
NUMBER AND TYPE OF ENGINE(S)	: 2 Detroit Diesel Allison 250-C30
SHAFT HORSE POWER (PER ENGINE)	: 676 HP (30 Min. rating)
MAXIMUM CONTINUOUS POWER	: 650 HP per engine
SPECIFIC FUEL CONSUMPTION AT MAXIMUM POWER (LB/HR/HP)	: .63 LB/HR/HP
NEVER EXCEED SPEED (V_{NE})	: 155 KTS
MAX SPEED IN LEVEL FLIGHT WITH MAX CONTINUOUS POWER (V_H)	: 145 KTS
SPEED FOR BEST RATE OF CLIMB (Vy)	: 74 KTS
BEST RATE OF CLIMB	: 1350 FT/MIN

MAIN AND TAIL ROTOR SPECIFICATIONS

	MAIN	TAIL
ROTOR SPEED (100%)	: 293 RPM	1611 RPM
DIAMETER	: 44 ft. (528 in.)	8 ft. (96 in.)
CHORD	: 15.6 in.	6.5 in.
NUMBER OF BLADES	: 4	4
PERIPHERAL VELOCITY	: 675 fps	674 fps
BLADE LOAD	: 88 lb/ft^2	———
FUNDAMENTAL BLADE PASSAGE FREQUENCY	: 20 Hz	107 Hz
ROTATIONAL TIP MACH NUMBER (77°F)	: .594	.594

TABLE 2.2

ICAO REFERENCE PARAMETERS

		TAKEOFF	APPROACH	LEVEL FLYOVER
AIRSPEED (KTS)	:	74	74	130
RATE OF CLIMB/DESCENT (fpm)	:	1350	789	NA
CLIMB/DESCENT ANGLE (DEGREES)	:	10.3	6.0	NA
ALTITUDE/CPA (FEET)				
SITE 5	:	276/272	342/340	492
SITE 1	:	366/360	394/392	492
SITE 4	:	456/499	446/443	492
SLANT RANGE (FEET) TO				
SITE 2	:	613	630	696
SITE 3	:	613	630	696

3.0 Test Synopsis - Below is a listing of pertinent details pertaining to the execution of the helicopter tests.

1. Test Sponsor, Program Management, and Data Analysis: Federal Aviation Administration, Office of Environment and Energy, Noise Abatement Division, Noise Technology Branch (AEE-120).

2. Test Helicopter: Sikorsky S-76A, provided by the FAA Rotorcraft Program Office.

3. Test Date: Monday, June 13, 1983.

4. Test Location: Dulles International Airport, Runway 30 over-run area.

5. Noise Data Measurement (recording), processing and analysis: Department of Transportation (DOT), Transportation Systems Center (TSC), Noise Measurement and Assessment Facility.

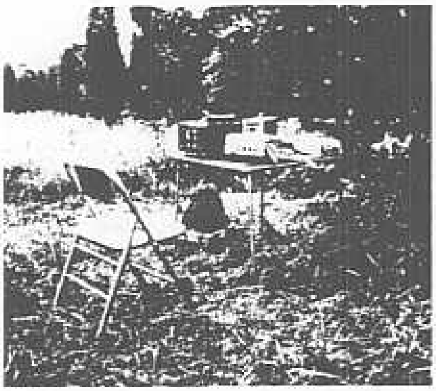
6. Noise Data Measurement (direct-read), processing and analysis: FAA, Noise Technology Branch (AEE-120).

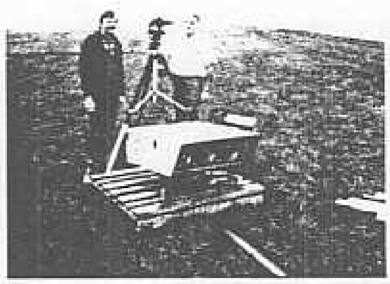
7. Cockpit instrument photo documentation; photo-altitude determination system; documentary photographs: Department of Transportation, Photographic Services Laboratory.

8. Meteorological Data (fifteen minute observations): National Weather Service Office, Dulles International Airport.

9. Meteorological Data (radiosonde/rawinsonde weather balloon launches): National Weather Service Upper Air Station, Sterling Park, Virginia.

Flight Test and Noise Measurement Personnel In Action





10. Meteorological Data (on site observations): DOT-TSC.

11. Flight Path Guidance (portable visual approach slope indicator (VASI) and theodolite/verbal course corrections): FAA Technical Center, ACT-310.

12. Air Traffic Control: Dulles International Airport Air Traffic Control Tower.

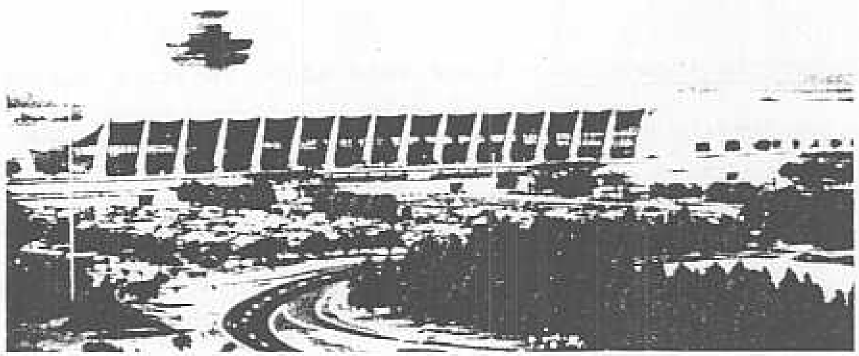
13. Test site preparation; surveying, clearing underbrush, connecting electrical power, providing markers, painting signs, and other physical arrangements: Dulles International Airport Grounds and Maintenance, and Airways Facilities personnel.

Figure 3.1 is a photo collage of flight test and measurement personnel performing their tasks.

3.1 Measurement Facility - The noise measurement testing area was located adjacent to the approach end of Runway 12 at Dulles International Airport. (The approach end of Runway 12 is synonymous with Runway 30 over-run area.) The low ambient noise level, the availability of emergency equipment, and the security of the area all made this location desirable. Figure 3.2 provides a photograph of the Dulles terminal and of the test area.

The test area adjacent to the runway was nominally flat with a ground cover of short, clipped grass, approximately 1800 feet by 2200 feet, and bordered on north, south, and west by woods. There was minimum interference from the commercial and general aviation activity at the airport since Runway 12/30 was closed to normal traffic during the tests. The runways used for normal traffic, 1L and 1R, were approximately 2 and 3 miles east, respectively, of the test site.

FIGURE 3.2



The Terminal and Air Traffic Control Tower
at Dulles International Airport

Approach to Runway 12 at Dulles Noise
Measurement Site for 1983 Helicopter Tests

The flight track centerline was located parallel to Runway 12/30 centered between the runway and the taxiway. The helicopter hover point for the static operations was located on the southwest corner of the approach end of Runway 12. Eight noise measurement sites were established in the grassy area adjacent to the Runway 12 approach ground track.

3.2 Microphone Locations - There were eight separate microphone sites located within the testing area, making up two measurement arrays. One array was used for the flight operations, the other for the static operations. A schematic of the test area is shown in Figure 3.3.

A. Flight Operations - The microphone array for flight operations consisted of two sideline sites, numbered 2 and 3 in Figure 3.3, and three centerline sites, numbered 5, 1, and 4, located directly below the flight path of the helicopter. Since site number 3, the north sideline site, was located in a lightly wooded area, it was offset 46 feet to the west to provide sufficient clearance from surrounding trees and bushes.

B. Static Operations - The microphone array for static operations consisted of sites 7H, 5H, 1H, 2, and 4H. These sites were situated around the helicopter hover point which was located on the southwest corner of the approach end of Runway 12. These site locations allowed for both hard and soft ground-to-ground propagation paths.

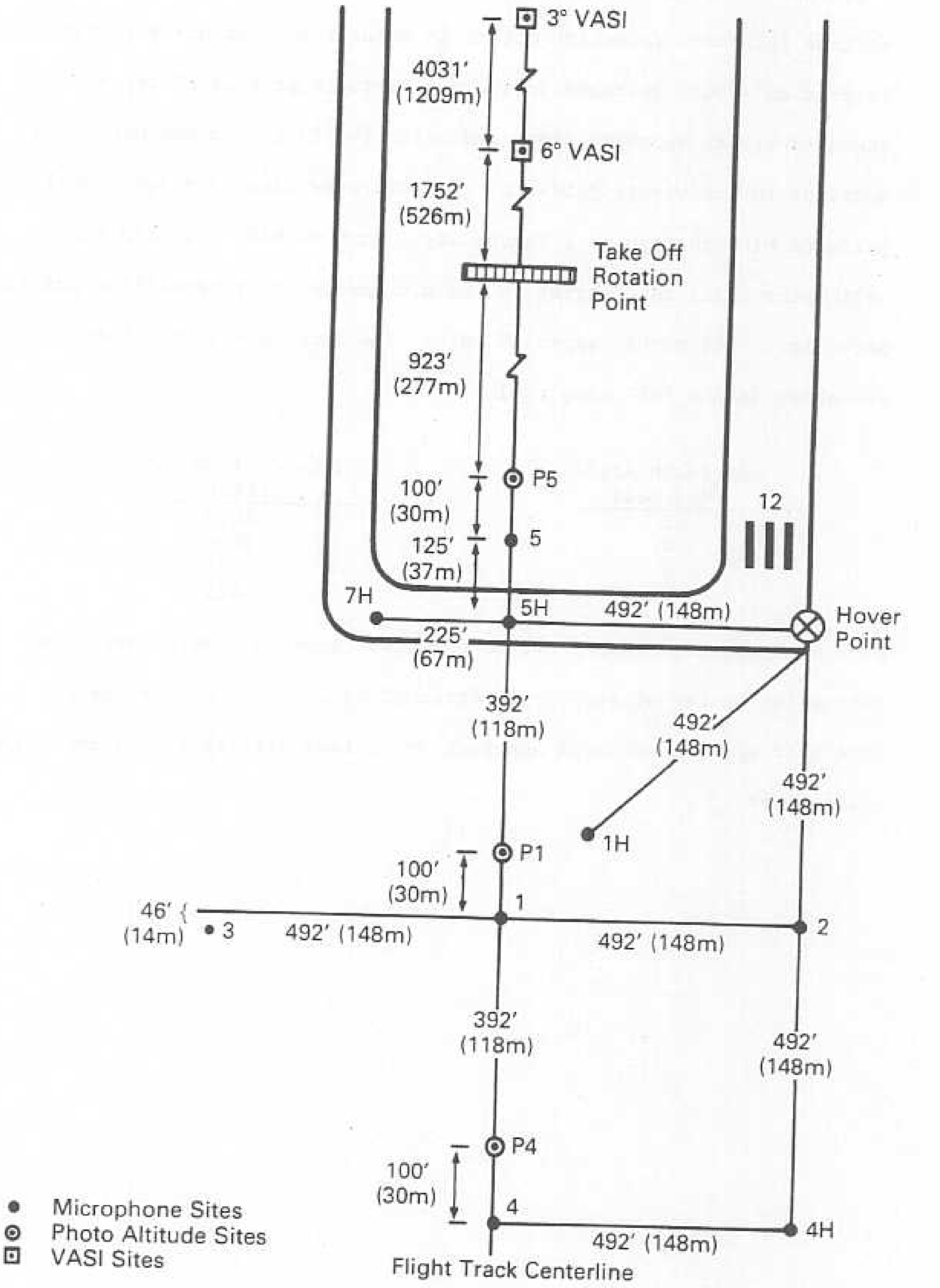
3.3 Flight Path Markers and Guidance System Locations - Visual cues in the form of squares of plywood painted bright yellow with a black "X" in the center were provided to define the takeoff rotation point. This point was located 1640 feet (500 m) from centerline center (CLC) microphone location. Four portable, battery-powered spotlights were deployed at various locations to assist pilots in maintaining the array centerline. To provide visual guidance during the approach portion of the test, a standard visual approach slope indicator (VASI) system was used. In addition to the visual guidance, the VASI crew also provided verbal guidance with the aid of a theodolite. Both methods assisted the helicopter pilot in adhering to the microphone array centerline and in maintaining the proper approach path. The locations of the VASI from CLC are shown in the following table.

Approach Angle (degrees)	Distance from CLC (feet)
12	1830
9	2456
6	3701
3	7423

Each of these locations provided a glidepath which crossed over the centerline center microphone location at an altitude of 394 feet. This test program included approach operations utilizing 3, 6 and 9 degree glide slopes.

FIGURE 3.3

Noise Measurement and Photo Site Schematic



NOTES: Broken Line Indicates not to Scale.
Metric Measurements to
Nearest Meter.

4.0 Test Planning/Background Activities - This section provides a brief discussion of important administrative and test planning activities.

4.1 Test Program Advance Briefings and Coordination - A pre-test briefing was conducted approximately one month prior to the test. The meeting was attended by all pilots participating in the test, along with FAA program managers, manufacturer test coordinators, and other key test participants from the Dulles Airport community. During this meeting, the airspace safety and communications protocol were rigorously defined and at the same time test participants were able to iron out logistical and procedural details. On the morning of the test, a final brief meeting was convened on the flight line to review safety rules and coordinate last-minute changes in the test schedule.

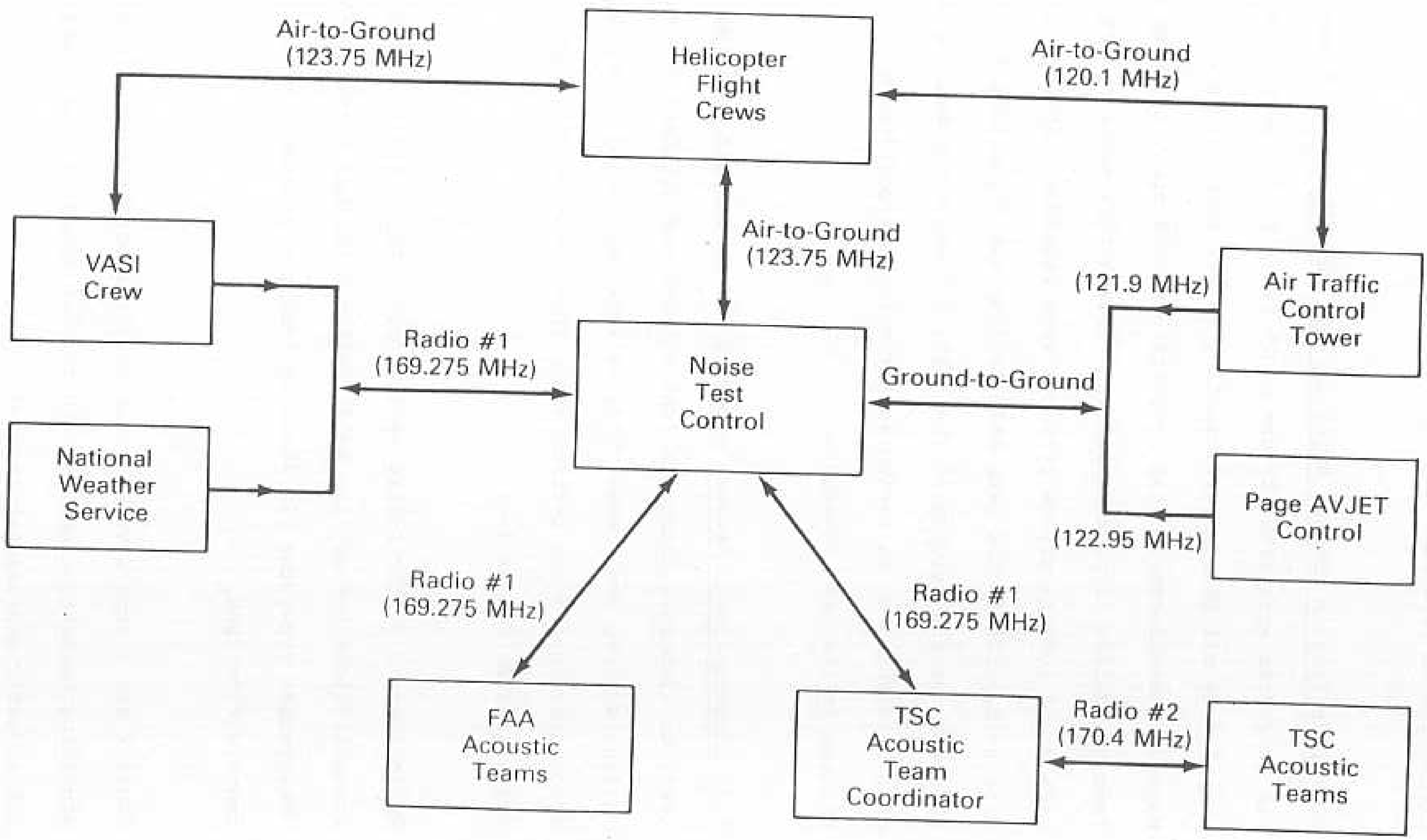
4.2 Communications Network - During the helicopter noise measurement test, an elaborate communications network was utilized to manage the various systems and crews. This network was headed by a central group which coordinated the testing using three two-way radio systems, designated as Radios 1-3.

Radio 1 was a walkie talkie system operating on 169.275 MHz, providing communications between the VASI, National Weather Service, FAA Acoustic Measurement crew, the TSC acoustic team coordinator, and the noise test coordinating team.

Radio 2 was a second walkie talkie system operating on 170.40 MHz, providing communications between the TSC acoustic team coordinator and the TSC acoustic measurement teams.

FIGURE 4.1

Helicopter Noise Test Communication Network Schematic



Radio 3, a multi-channel transceiver, was used as both an air-to-ground and ground-to-ground communications system. In air-to-ground mode it provided communications between VASI, helicopter flight crews, and noise test control on 123.175 MHz. In ground-to-ground mode it provided communications between the air traffic control tower (121.9 MHz), Page Avjet (the fuel source; 122.95 MHz), and noise test control. A schematic of this network is shown in Figure 4.1.

4.3 Local Media Notification - Noise test program managers working through the FAA Office of Public Affairs released an article to the local media explaining that helicopter noise tests were to be conducted at Dulles Airport on June 13, the test day commencing around dawn and extending through midday. The article described general test objectives, flight paths, and rationale behind the very early morning start time (low wind requirements). In the case of a farm located very close to the airport, a member of the program management team personally visited the residents and explained what was going to be involved in the test. As a consequence of these efforts (it is assumed), there were very few complaints about the test program.

4.4 Ambient Noise - One of the reasons that the Dulles Runway 30 over-run area was selected as the test site was the low ambient noise level in the area. Typically one observed an A-Weighted LEQ on the order of 45 dB, with dominant transient noise sources primarily from the avian and insect families. The primary offender was the Collinus Virginianus, commonly known as the bobwhite, quail, or partridge. The infrequent intrusive sound pressure levels were on the order of 55 dB centered in the 2000 Hz one-third octave band. A drawing of the noisy offender and narrow band analysis of the song may be found in Figure 4.2.

As an additional measure for safety and for lessening ambient noise, a Notice to Airmen or NOTAM was issued advising aircraft of the noise test, and indicating that Runway 12/30 was closed for the duration of the test.

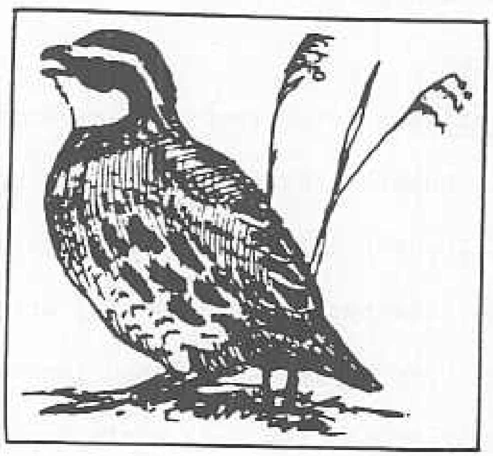
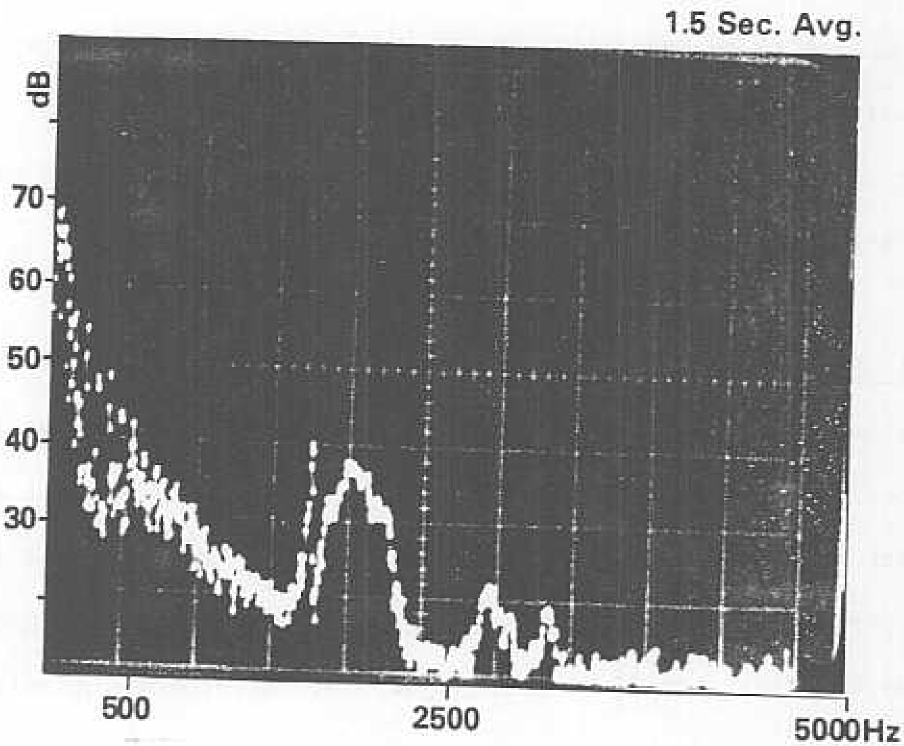


FIGURE 4.2



5.0 Data Acquisition and Guidance Systems - This section provides a detailed description of the test program data acquisition systems, with special attention given to documenting the operational accuracy of each system. In addition, discussion is provided (as needed) of field experiences which might be of help to others engaged in controlled helicopter noise measurements. In each case, the location of a given measurement system is described relative to the helicopter flight path.

5.1 Approach Guidance System - Approach guidance was provided to the pilot by means of a visual approach slope indicator (VASI) and through verbal commands from an observer using a ballon-tracking theodolite. (A picture of the theodolite is included in Figure 3.1, in Section 3.0.) The VASI and theodolite were positioned at the point where the approach path intercepted the ground.

The VASI system used in the test was a 3-light arrangement giving vertical displacement information within ± 0.5 degrees of the reference approach slope. The pilot observed a green light if the helicopter was within 0.5 degrees of the approach slope, red if below the approach slope, white if above. The VASI was adjusted and repositioned to provide a variety of approach angles. A picture of the VASI is included in Figure 3.1.

The theodolite system, used in conjunction with the VASI, also provided accurate approach guidance to the pilot. A brief time lag existed between the instant the theodolite observor perceived deviation, transmitted a command, and the pilot made the correction; however, the theodolite crew was generally able to alert the pilot of approach path deviations (slope and lateral displacement) before the helicopter exceeded the limits of the one degree green light of the VASI. Thus, the helicopter only occasionally and temporarily deviated more than 0.5 degrees from the reference approach path.

Approach paths of 3, 6 and 9 degrees were used during the test program. Table 5.1 summarizes the VASI beam width at each measurement location for a variety of the approach angles used in this test.

TABLE 5.1

REFERENCE HELICOPTER ALTITUDES FOR APPROACH TESTS
(all distances expressed in feet)

	MICROPHONE NO. 4	MICROPHONE NO. 1	MICROPHONE NO. 5
APPROACH ANGLE = 3°	A = 8010 B = 420 C = ±70	A = 7518 B = 394 C = ±66	A = 7026 B = 368 C = ±62
6°	A = 4241 B = 446 C = ±37	A = 3749 B = 394 C = ±33	A = 3257 B = 342 C = ±29
9°	A = 2980 B = 472 C = ±27	A = 2488 B = 394 C = ±22	A = 1362 B = 316 C = ±18

A = distance from VASI to microphone location

B = reference helicopter altitude

C = boundary of the 1 degree VASI glide slope "beam width".

5.2 Photo Altitude Determination Systems - The helicopter altitude over a given microphone was determined by the photographic technique described in the Society of Automotive Engineers report AIR-902 (ref. 1). This technique involves photographing an aircraft during a flyover event and proportionally scaling the resulting image with the known dimensions of the aircraft. The camera is initially calibrated by photographing a test object of known size and distance. Measuring the resulting image enables calculation of the effective focal length from the proportional relationship:

(image length)/(object length) = (effective focal length)/(object distance)

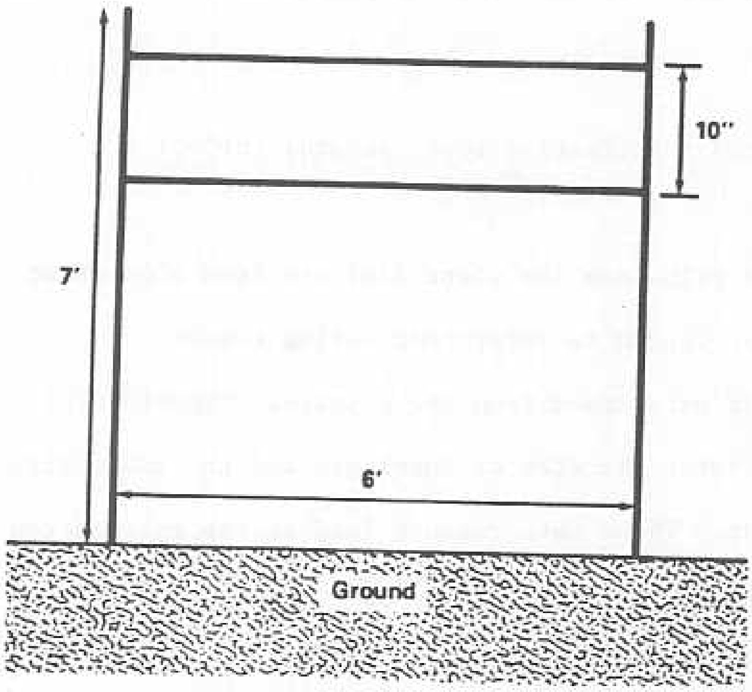
This relationship is used to calculate the slant distance from microphone to aircraft. Effective focal length is determined during camera calibration, object length is determined from the physical dimensions of the aircraft (typically the rotor diameter or fuselage) and the image size is measured on the photograph. These measurements lead to the calculation of object distance, or the slant distance from camera or microphone to aircraft. The concept applies similarly to measuring an image on a print, or measuring a projected image from a slide.

The SAE AIR-902 technique was implemented during the 1983 helicopter tests with three 35mm single lens reflex (SLR) cameras using slide film. A camera was positioned 100 feet from each of the centerline microphone locations. Lenses with different focal lengths, each individually calibrated, were used in photographing helicopters at differing altitudes in order to more fully "fill the frame" and reduce image measurement error.

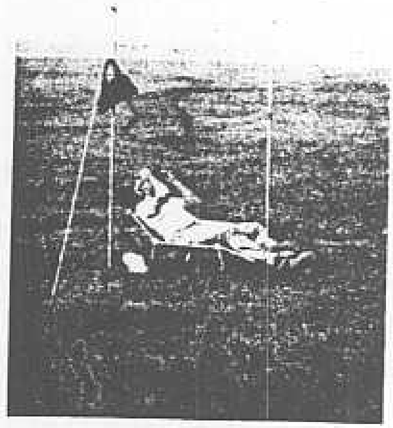
The photoscaling technique assumes the aircraft is photographed directly overhead. Although SAE AIR-902 does present equations to account for deviations caused by photographing too soon or late, or by the aircraft deviating from the centerline, these corrections are not required when

Figure 5.1

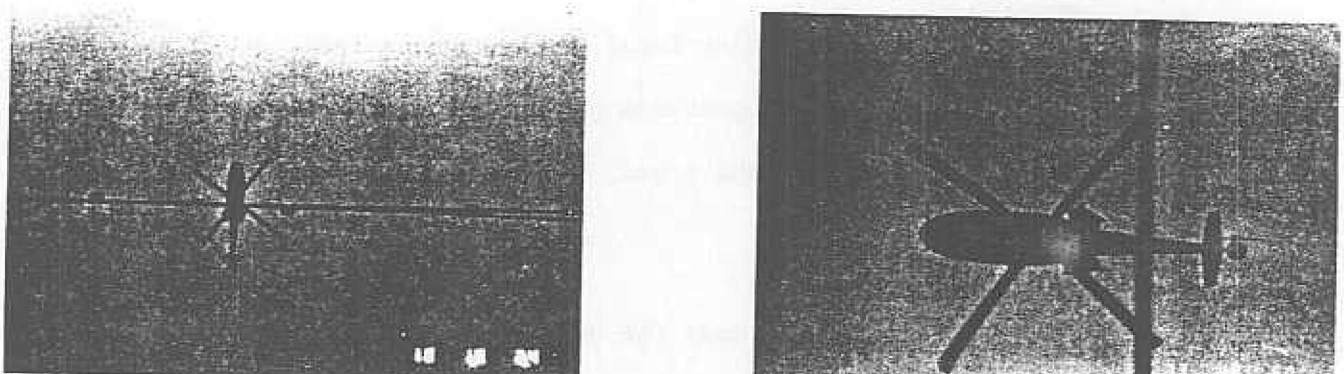
Photo Overhead Positioning System (Pop System)



Artist's Drawing of the Photo Overhead Positioning System (Figure is not to scale.)



Photographer using the POP system to photograph the helicopter.



Photographs of the Sikorsky S-76A, as taken by the photographer using the POP system.

deviations are small. Typically, most of the deviations were acoustically insignificant. Consequently, corrections were not required for any of the 1983 test photos.

The photographer was aided in estimating when the helicopter was directly overhead by means of a photo-overhead positioning system (POPS) as illustrated in the figure and pictures in Figure 5.1 The POP system consisted of two parallel (to the ground) wires in a vertical plane orthogonal to the flight path. The photographer, lying beneath the POP system, initially positioned the camera to coincide with the vertical plane of the two guide wires. The photographer tracked the approaching helicopter in the viewfinder and tripped the shutter when the helicopter crossed the superimposed wires. This process of tracking the helicopter also minimized image blurring and the consequent elongation of the image of the fuselage.

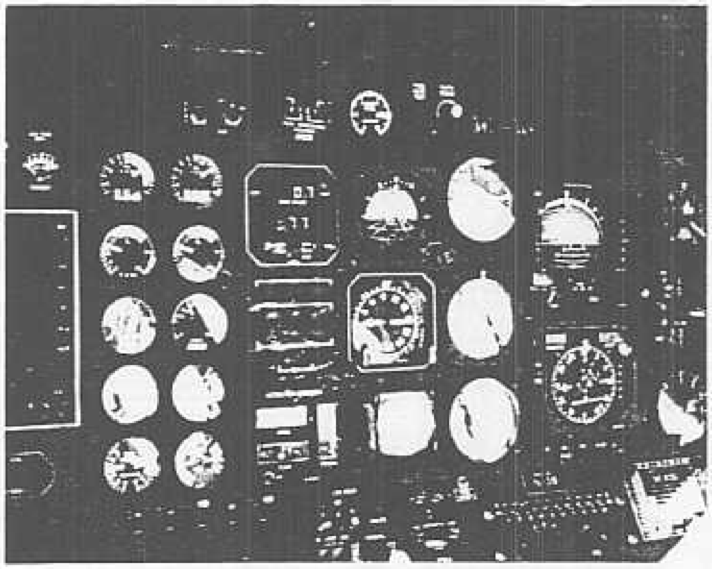
A scale graduated in 1/32-inch increments was used to measure the projected image. This scaling resolution translated to an error in altitude of less than one percent. A potential error lies in the scaler's interpretation of the edge of the image. In an effort to quantify this error, a test group of ten individuals measured a selection of the fuzziest photographs from the helcopter tests. The resulting statistics revealed that 2/3 of the participants were within two percent of the mean altitude. SAE AIR-902 indicates that the overall photoscaling technique, under even the most extreme conditions, rarely produces error exceeding 12 percent, which is equivalent to a maximum of 1 dB error in corrected sound level data. Actual accuracy varies from photo to photo; however, by using skilled photographers and exercising reasonable care in the measurements, the accuracy is good enough to ignore the resulting small error in altitude.

Tests were recently conducted in West Germany which compared this camera method with the more elaborate Kinotheodolite tracking method to discover which was best for determining overflight height and overground speed. Both methods were found to be reasonably accurate; thus, the simpler camera method remains appropriate for test purposes (ref. 2).

5.3 Cockpit Photo Data - During each flight operation of the test program, cockpit instrument panel photographs were taken with a 35mm SLR camera, with an 85mm lens, and high speed slide film. These pictures served as verification of the helicopter's speed, altitude, and torque at a particular point during a test event. The photos were intended to be taken when the aircraft was directly over the centerline-center microphone site #1 (see Figure 3.3). Although the photos were not always taken at precisely that point, the pictures do represent a typical moment during the test event. The word typical is important because the snapshot freezes instrument readings at one moment in time, while actually the readings are constantly changing by a small amount because of instrument fluctuation and pilot input. Thus, fluctuations above or below reference conditions are to be anticipated. A reproduction of a typical cockpit photo is shown in Figure 5.2. When slides were projected onto a screen, it was possible to read and record the instrument readings with reasonable accuracy. This data acquisition system was augmented by the presence of an experienced cockpit obersver who provided additional documentation of operational parameters.

For future tests, the use of a video tape system is being considered to acquire a continuous record of cockpit parameters during each data run. Preliminary FAA studies (April 1984) indicate that this technique can be successful using off the shelf equipment.

FIGURE 5.2



5.4 Upper Air Meteorological Data Acquisition/NWS: Sterling, VA - The National Weather Service (NWS) at Sterling, Virginia provided upper air meteorological data obtained from balloon-borne radiosondes. These data consisted of pressure, temperature, relative humidity, wind direction, and speed at 100′ intervals from ground level through the highest test altitude. The balloons were launched approximately 2 miles north of the measurement array. To slow the ascent rate of the balloon, an inverted parachute was attached to the end of the flight train. The VIZ Accu-Lok (manufacturer) radiosonde employed in these tests consisted of sensors which sampled the ambient temperature, relative humidity, and pressure of the air. Each radiosonde was individually calibrated by the manufacturer. The sensors were coupled to a radio transmitter which emitted an RF signal of 1680 MHz sequentially pulse-modulated at rates corresponding to the values of sampled meteorological parameters. These signals were received by the ground-based tracking system and converted into a continuous trace on a strip chart recorder. The levels were then extracted manually and entered into a minicomputer where calculations were performed. Wind speed and direction were determined from changes in position and direction of the "flight train" as detected by the radiosonde tracking system. Figure 5.3 shows technicians preparing to launch a radiosonde.

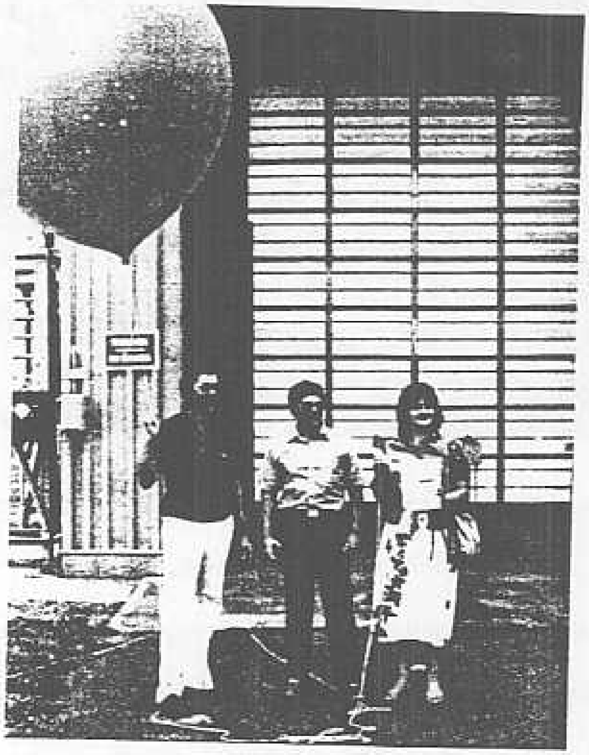


FIGURE 5.3

The manufacturer's specifications for accuracy are:

Pressure = ± 4 mb up to 250 mb

Temperature = ± 0.5`C, over a range of +30`C to -30`C

Humidity = ± 5% over a range of ± 25`C to 5`C

The National Weather Service has determined the "operational accuracy" of a radiosonde (as documented in an unpublished report entitled "Standard for Weather Bureau Field Programs", 1-1-67) to be as follows:

Pressure = ± 2 mb, over a range of 1050mb to 5 mb

Temperature = ± 1`C, over a range of +50`C to -70`C

Humidity = ± 5% over a range of +40`C to -40`C

The temperature and pressure data are considered accurate enough for general documentary purposes. The relative humidity data are the least reliable. The radiosonde reports lower than actual humidities when the air is near saturation. These inaccuracies are attributable to the slow response time of the humidity sensor to sudden changes. (Ref. 3).

For future testing, the use of a SODAR (acoustical sounding) system is being considered. The SODAR is a measurement system capable of defining the micro-wind structure, making the influences of wind speed, direction and gradient easier to identify and to assess in real time (Ref. 4).

5.5 Surface Meteorological Data Acquisition/NWS: Dulles Airport - The National Weather Service Station at Dulles provided temperature, windspeed, and wind direction on the test day. Readings were noted every 15 minutes. These data are presented in Appendix H. The temperature transducers were located approximately 2.5 miles east of the test site at a height of 6 feet (1.8 m) above the ground, the wind instruments were at a height of 30 feet (10 m) above ground level. The dry bulb thermometer and dew point transducer were contained in the Bristol (manufacturer) HO-61 system operating with ± one degree accuracy. The windspeed and direction were measured with the Electric Speed Indicator (manufacturer) F420C System, operating with an accuracy of 1 knot and ±5`.

On-site meterological data were also obtained by TSC personnel using a Climatronics (manufacturer) model EWS weather system. The anemometer and temperature sensor were located 10 feet above ground level at noise site 4. These data are presented in Appendix I. The following table

(Table 5.2) identifies the accuracy of the individual components of the EWS system.

TABLE 5.2

Sensor	Accuracy	Range	Time Constant
Windspeed	±.025 mph or 1.5%	0-100 mph	5 sec
Wind Direction	±1.5%	0-360°	15 sec
Relative Humidity	±2% 0-100% RH	0-100% RH	10 sec
Temperature	±1.0°F	-40 to +120°F	10 sec

After "detection" (sensing), the meteorological data are recorded on a Rustrak (manufacturer) paperchart recorder. The following table (Table 5.3) identifies the range and resolutions associated with the recording of each parameter.

TABLE 5.3

Sensor	Range	Chart Resolution
Windspeed	0-25 TSC mod 0-50 mph	±0.5 mph
Wind Direction	0-360°	±5°
Relative Humidity	0-100% RH	±2% RH
Temperature	-40° to 120°F	±1°F

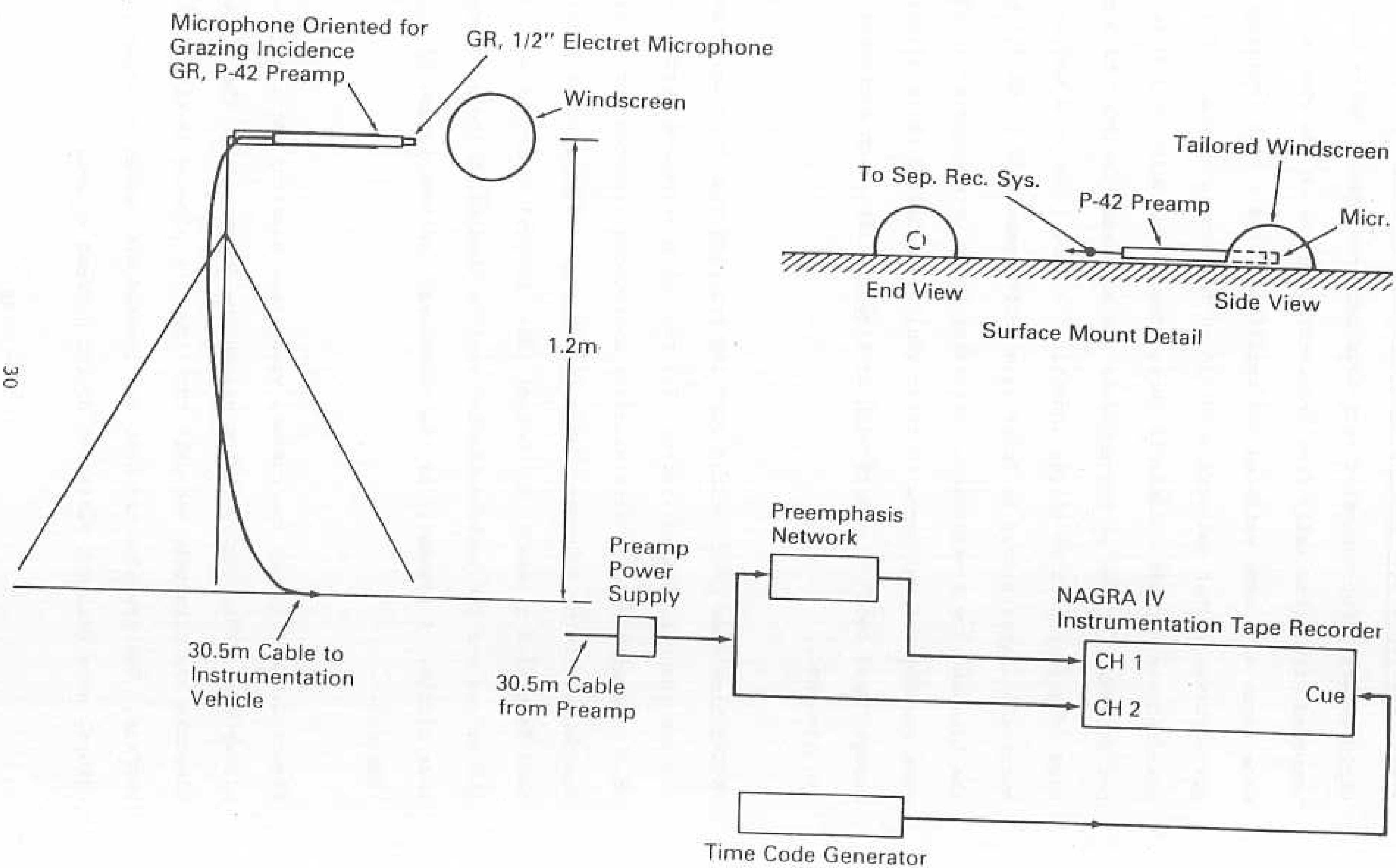
5.6.0 Noise Data Acquisition Sytems/System Deployment - This section provides a detailed description of the acoustical measurement systems employed in the test program along with the deployment plan utilized in each phase of testing.

5.6.1 Description of TSC Magnetic Recording Systems - TSC personnel deployed Nagra two-channel direct-mode tape recorders. Noise data were recorded with essentially flat frequency response on one channel. The same input data were weighted and amplified using a high frequency pre-emphasis filter and were recorded on the second channel. The pre-emphasis network rolled off those frequencies below 10,000 Hz at 20 dB per decade. The use of pre-emphasis was necessary in order to boost the high frequency portion of the acoustical signal (such as a helicopter spectrum) characterized by large level differences (30 to 60 dB) between the high and low frequencies. Recording gains were adjusted so that the best possible signal-to-noise ratio would be achieved while allowing enough "head room" to comply with applicable distortion avoidance requirements.

IRIG-B time code synchronized with the tracking time base was recorded on the cue channel of each system. The typical measurement system consisted of a General Radio 1/2 inch electret microphone oriented for grazing incidence driving a General Radio P-42 preamp and mounted at a height of four feet (1.2 meters). A 100-foot (30.5 meters) cable was used between the tripod and the instrumentation vehicle located at the perimeter of the test circle. A schematic of the acoustical instrumentation is shown in Figure 5.4.

Figure 5.4 also shows the cutaway windscreen mounting for the ground microphone. This configuration places the lower edge of the microphone diaphram approximately one-half inch from the plywood (4 ft by 4 ft) surface. The ground microphone was located off center in order to avoid natural mode resonant vibration of the plywood square.

FIGURE 5.4
Acoustical Measurement Instrumentation



5.6.2 FAA Direct Read Measurement Systems - In addition to the recording systems deployed by TSC, four direct read, Type-1 noise measurement systems were deployed at selected sites. Each noise measurement site consisted of an identical microphone-preamplifier system comprised of a General Radio 1/2-inch electret microphone (1962-9610) driving a General Radio P-42 preamplifier mounted 4 feet (1.2m) above the ground and oriented for grazing incidence. Each microphone was covered with a 3-inch windscreen.

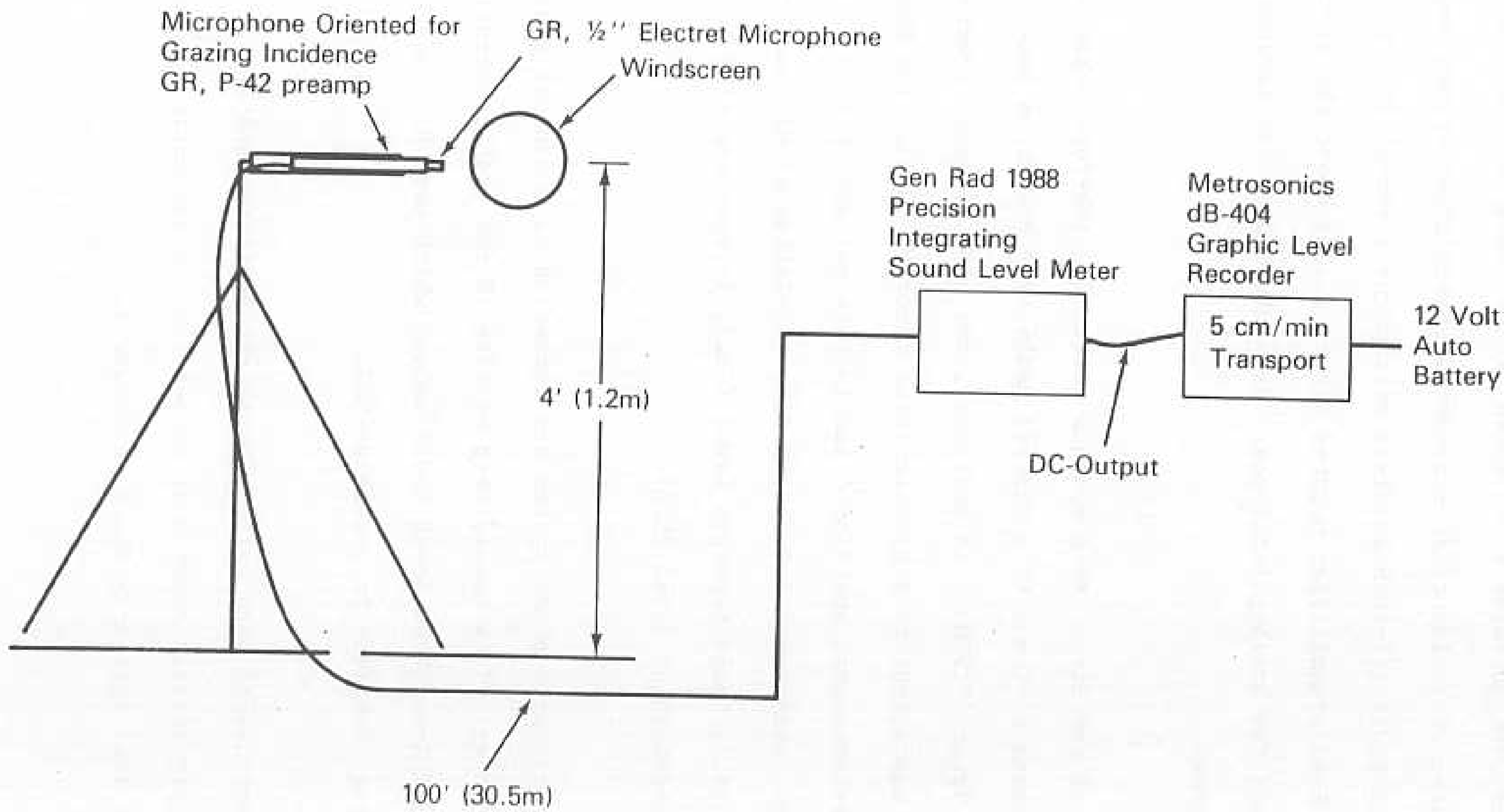
Three of the direct read systems utilized a 100-foot cable connecting the microphone system with a General Radio 1988 Precision Integrating Sound Level Meter (PISLM). In each case, the slow response A-weighted sound level was output to a graphic level recorder (GLR). The GLRs operated at a paper transport speed of 5 centimeters per minute (300 cm/hr). These systems collected single event data consisting of maximum A-weighted Sound Level (AL), Sound Exposure Level (SEL), integration time (T), and equivalent sound level (LEQ).

The fourth microphone system was connected to a General Radio 1981B Sound Level Meter. This meter, used at site 7H for static operations only, provided A-weighted Sound Level values which were processed using a micro sampling technique to determine LEQ.

All instruments were calibrated at the beginning and end of each test day and approximately every hour in between. A schematic drawing of the basic direct read system is shown in Figure 5.5.

FIGURE 5.5

Acoustical Measurement Instrumentation



Direct Read Noise Measurement System

5.6.3 Deployment of Acoustical Measurement Instrumentation - This section describes the deployment of the magnetic tape recording and direct read noise measurement systems.

During the testing, TSC deployed six magnetic tape recording systems. During the flight operations, four of these recording system were located at the three centerline sites: one system at site 4, one at site 5, and two at centerline center with the microphone of one of those systems at 4 feet above ground, the microphone of the other at ground level. The two remaining recording systems were located at the two sidelines sites. The FAA deployed three direct read systems at the three centerline sites during the flight operations. Figure 5.6 provides a schematic drawing of the equipment deployment for the flight operations. The only exception to this deployment scheme was the removal of personnel and equipment from site 1 during test series O_2.

In the case of static operations, only four of the six recorder systems were used. The recorder system with the 4-foot microphone at site 1 moved to site 1H. The recorders at sites 4 and 5 moved to 4H and 5H respectively. The recorder at site 2, the south sideline site, was also used. The three direct read systems were moved from the centerline sites to sites 5H, 2, and 4H. The fourth direct read system was employed at site 7H. Figure 5.7 provides a schematic diagram of the equipment deployment for the static operations.

FIGURE 5.6

Microphone and Acoustical Measurement Instrument Deployment Flight Operations

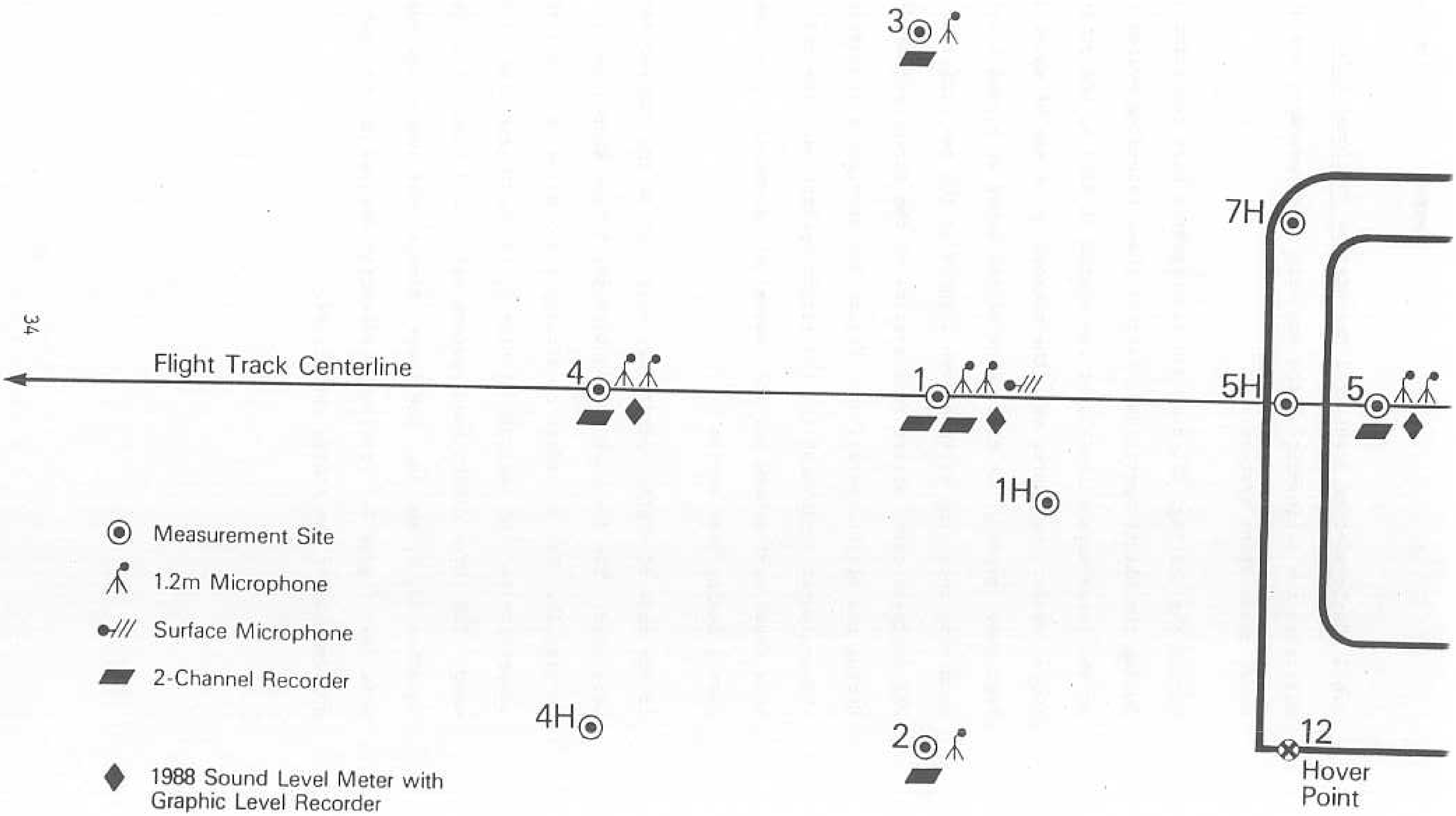
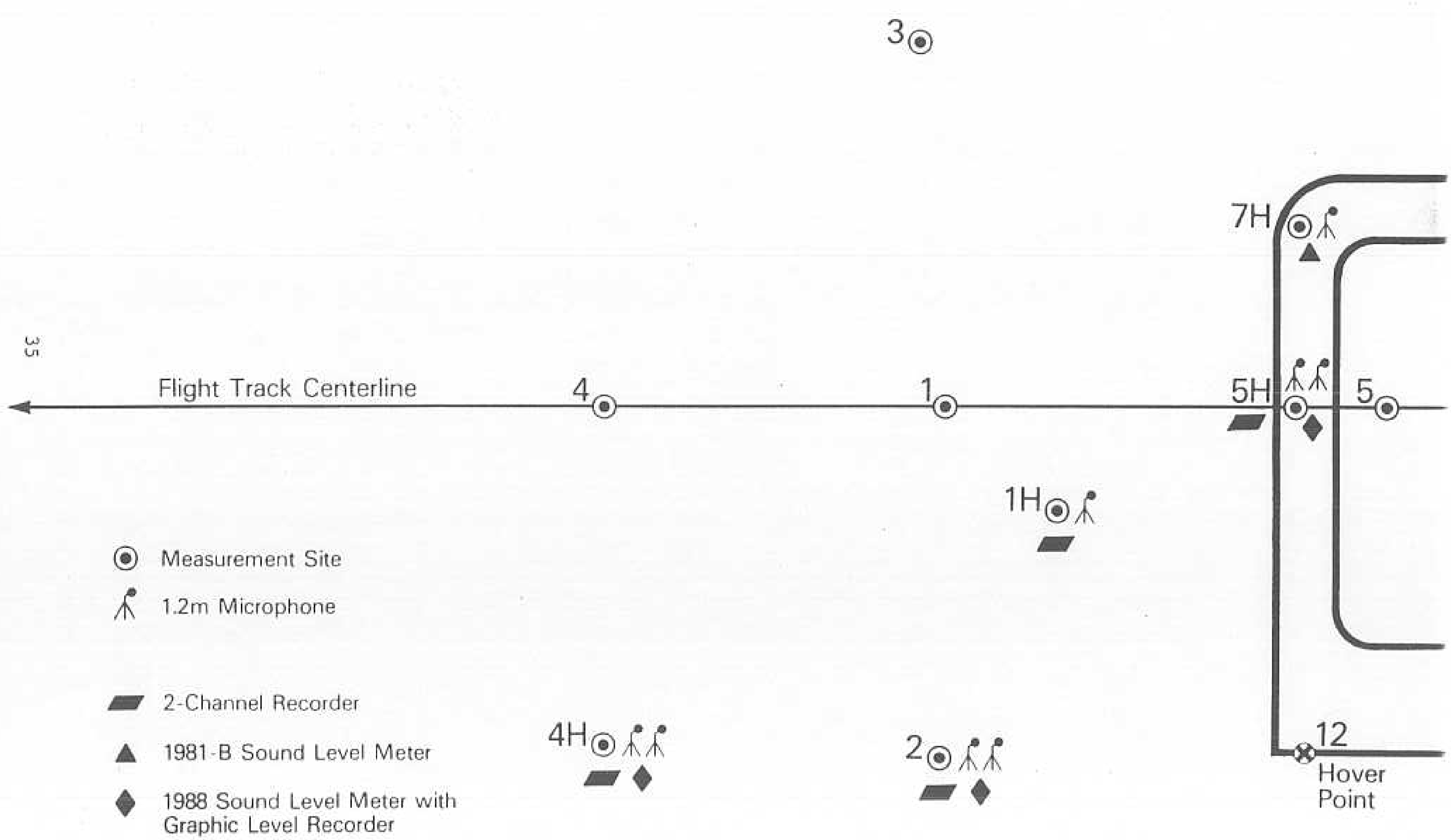


FIGURE 5.7

Microphone and Acoustical Measurement Instrument Deployment Static Operations



6.0 Acoustical Data Reduction - This section describes the treatment of tape recorded and direct read acoustical data from the point of acquisition to point of entry into the data tables shown in the appendices of this document.

6.1 TSC Magnetic Recording Data Reduction - The analog magnetic tape recordings analyzed at the TSC facility in Cambridge, Massachusetts were fed into magnetic disc storage after filtering and digitizing using the GenRad 1921 one-third octave real-time analyzer. Figure 6.1 is a picture of the TSC facility; Figure 6.2 provides a flow chart of the data collection, reduction and out process accomplish by TSC personnel. Recording system frequency response adjustments were applied, assuring overall linearity of the recording and reduction system. The stored 24, one-third octave sound pressure levels (SPLs) for contiguous one-half second integration periods making up each event comprise the base of "raw data." Data reduction followed the basic procedures defined in Federal Aviation Regulation (FAR) Part 36 (Ref. 3). The following sections describe the steps involved in arriving at final sound level values.

FIGURE 6.1

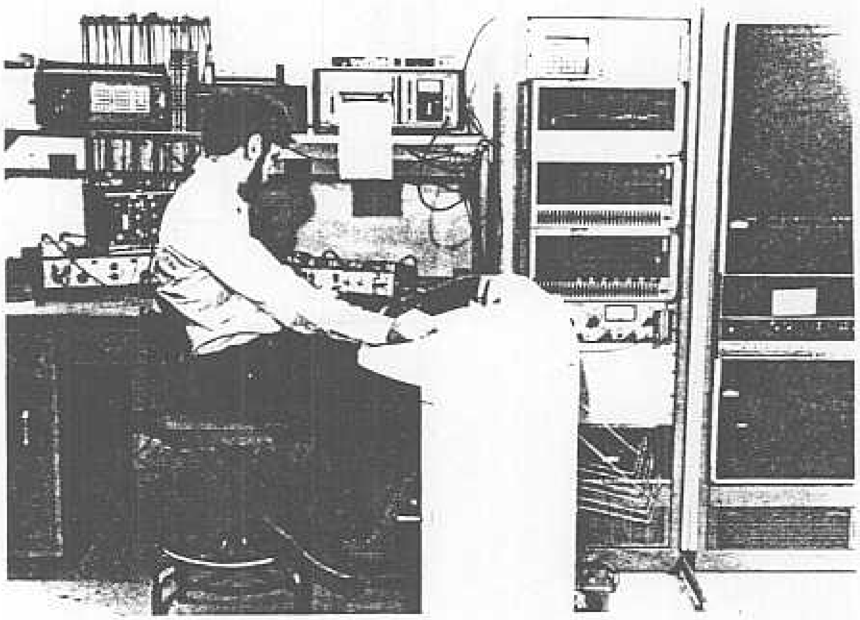
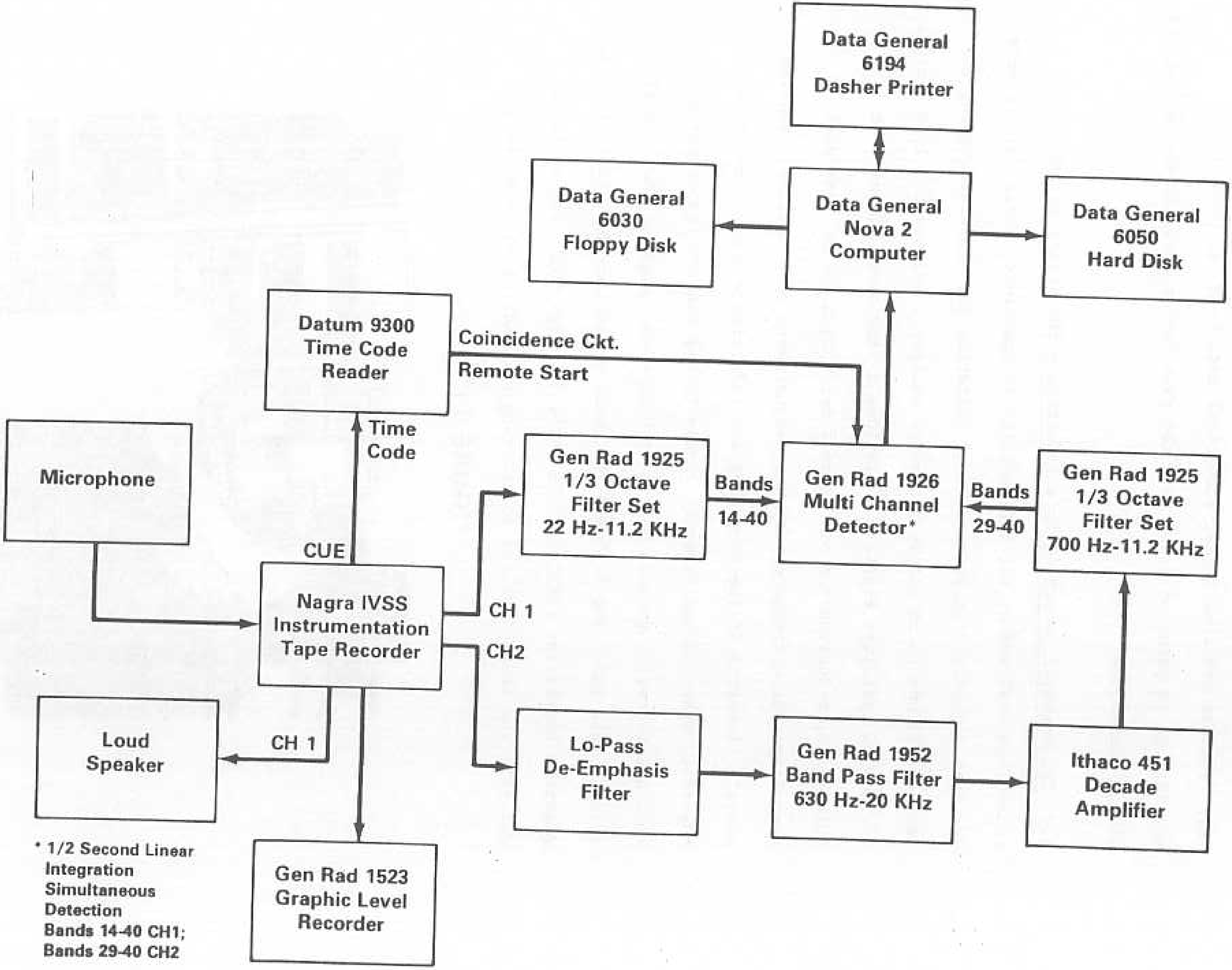


FIGURE 6.2

Acoustical Data Reduction/Instrumentation



6.1.1 Ambient Noise - The ambient noise is considered to consist of both the acoustical background noise and the electrical noise of the measurement system. For each event, the ambient level was taken as the five to ten-second time averaged one-third octave band taken immediately prior to the event. The ambient noise was used to correct the measured raw spectral data by subtracting the ambient level from the measured noise levels on an energy basis. This subtraction yielded the corrected noise level of the aircraft. The following execptions are noted:

1. At one-third octave frequencies of 630 Hz and below, if the measured level was within 3 dB of the ambient level, the measured level was corrected by being set equal to the ambient. If the measured level was less than the ambient level, the measured level was not corrected.

2. At one-third octave frequencies above 630 Hz, if the measured level was within 3 dB or less of the ambient, the level was identified as "masked."

6.1.2 Spectral Shaping - The raw spectral data, corrected for ambient noise, were adjusted by sloping the spectrum shape at -2 dB per one-third octave for those bands (above 1.25 kHz) where the signal to noise ratio was less than 3 dB, i.e., "masked" bands. This procedure was applied in cases involving no more than 9 "masked" one-third octave bands. The shaping of the spectrum over this 9-band range was conducted to minimize EPNL data loss. This spectral shaping methodology deviates from FAR-36 procedures in that the extrapolation includes four more bands than normally allowed.

6.1.3 Analysis System Time Constant/Slow Response - The corrected raw spectral data (contiguous linear 1/2 second records of data) were processed using a sliding window or weighted running logarithmic averaging procedure to achieve the "slow" dynamic response equivalent to the "slow response" characteristic of sound level meters as required under the provisions of FAR-36. The following relationship using four consecutive data records was used:

$$L_i = 10 \text{ Log } [0.13(10.^{0.1L_{i-3}})+0.21(10.^{0.1L_{i-2}})+0.27(10.^{0.1L_{i-1}})+0.39(10.^{0.1L_i})]$$

where L_i is the one-third octave band sound pressure level for the ith one-half second record number.

6.1.4 Bandsharing of Tones - All calculations of PNLTM included testing for the presence of band sharing and adjustment in accordance with the procedures defined in FAR-36, Appendix B, Section B 36.2.3.3, (Ref. 6).

6.1.5 Tone Corrections - Tone corrections were computed using the helicopter acoustical spectrum from 24 Hz to 11,200 Hz, (bands 14 through 40). Tone correction values were computed for bands 17 through 40, the same set of bands used in computing the EPNL and PNLT. The initiation of the tone correction procedure at a lower frequency reflects recognition of the strong low frequency tonal content of helicopter noise. This procedure is in accordance with the requirements of ICAO Annex 16, Appendix 4, paragraph 4.3. (Ref. 7)

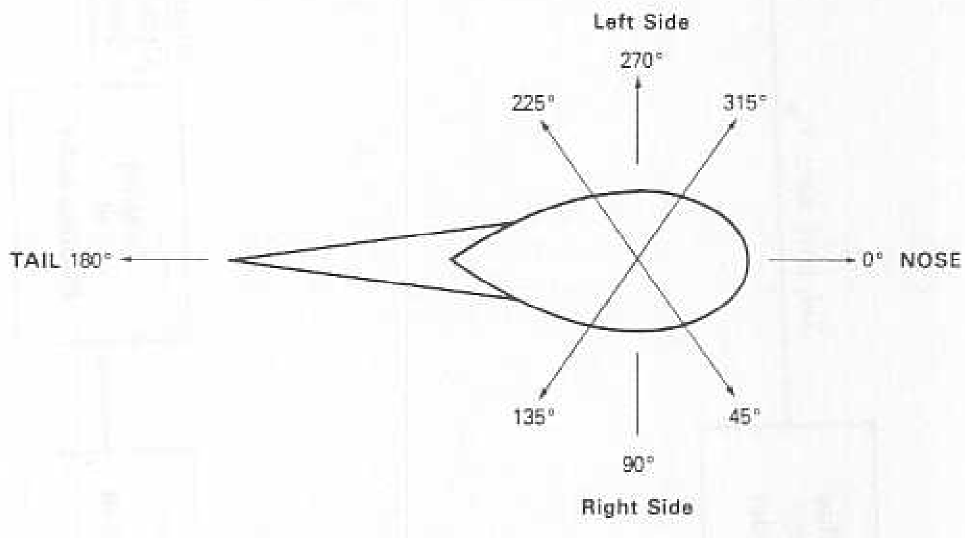
6.1.6 Other Metrics - In addition to the EPNL/PNLT family of metrics and the SEL/AL family, the overall sound pressure level and 10-dB down duration times are presented as part of the "As Measured" data set in Appendix A. Two factors relating to the event time history (distance duration and speed corrections, discussed in a later section) are also presented.

6.1.7 Spectral Data/Static Tests - In the case of static operations, thirty-two seconds of corrected raw spectral data (64 contiguous 1/2 second data records) were energy averaged to produce the data tabulated in Appendix C. The spectral data presented is "as measured" at the emission angles shown in Figure 6.3, established relative to each microphone location. Also included in the tables are the 360 degree (eight emission angles) average levels, calculated by both arithmetic and energy averaging.

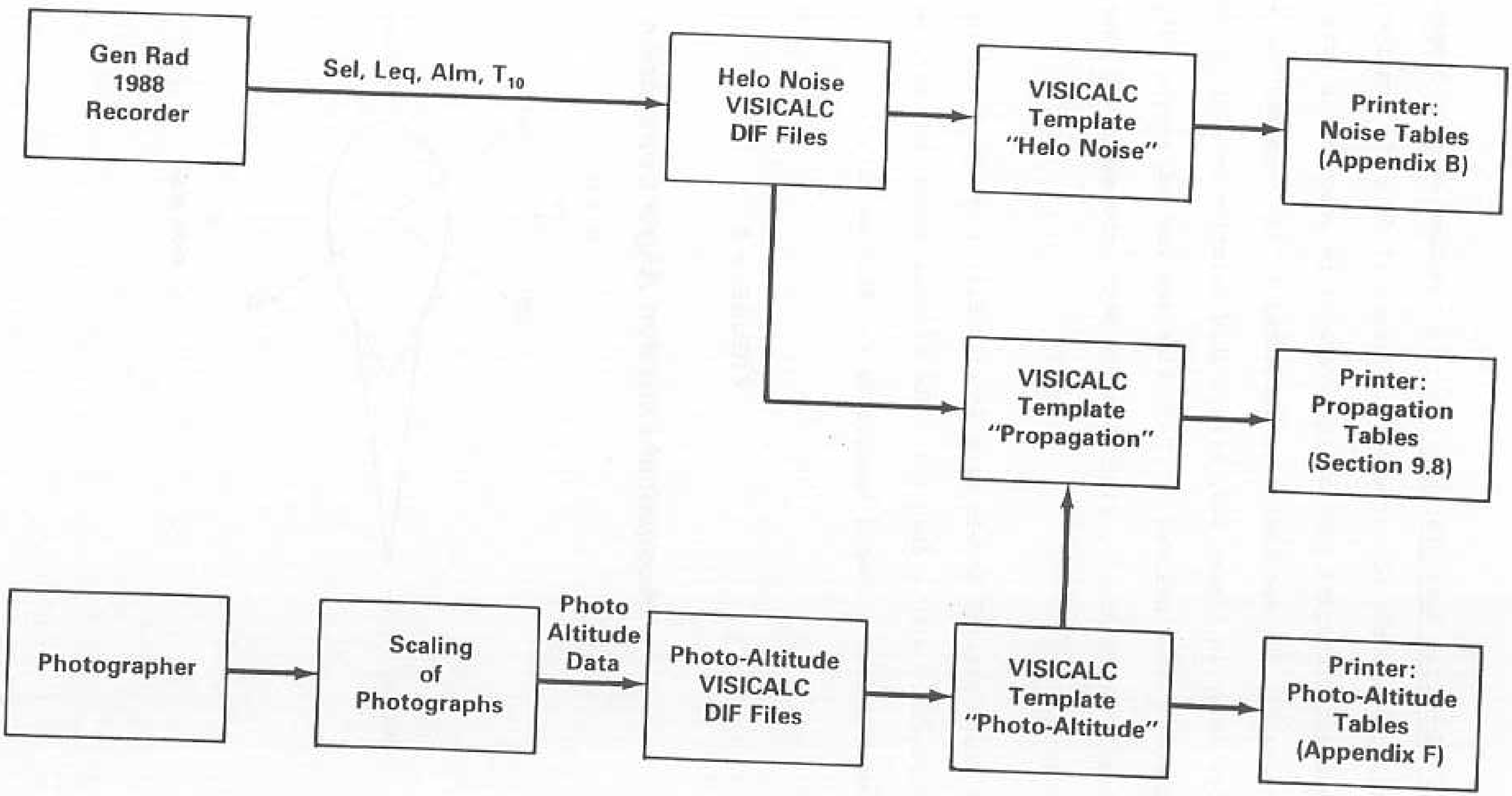
Note that "masked" levels (see Section 6.1.1) are replaced in the tables of Appendix C with a dash (-). The indexes shown, however, were calculated with a shaped spectra as per Section 6.1.2.

FIGURE 6.3

Acoustical Emission Angle Convention



Direct Read Data Reduction



6.2 FAA Direct Read Data Reduction - Figure 6.4 provides a flow diagram of the data collection, reduction and output process effected by FAA personnel. FAA direct read data was reduced using the Apple IIe microcomputer and the VISICALC® software package. VISICALC® is an electronic worksheet composed of 256 x 256 rows and columns which can support mathematical manipulation of the data placed anywhere on the worksheet. This form of computer software lends itself to a variety of data analyses, by means of constructing templates (worksheets constructed for specific purposes). Data files can be constructed to contain a variety of information such as noise data and position data using a file format called DIF (data interchange format).

Data analysis can be performed by loading DIF files onto analysis templates. The output or results can be displayed in a format suitable for inclusion in reports or presentations. Data tables generated using these techniques are contained in Appendices B and D, and are discussed in Section 9.0.

6.2.1 Aircraft Position and Trajectory - A VISICALC® DIF file was created to contain the photo altitude data for each event of each test series for the test conducted. These data were input into a VISICALC® template designed to perform a 3-point regression through the photo altitude data from which estimates of aircraft altitudes could be determined for each microphone location.

6.2.2 Direct Read Noise Data - Another template was designed to take two VISICALC\ DIF files as input. The first contained the "as measured" noise levels SEL and dBA obtained from the FAA direct read systems and the 10-dB duration time obtained from the graphic level recorder for each of the three microphone sites.

The second consisted of the estimates of aircraft altitude over three microphone sites. Calculations using the two input files determined two figures of merit related to the event duration influences on the SEL energy dose metric. This analysis is described in Section 9.4. All of the available template output data are presented in Appendix B.

7.0 Test Series Description - The noise-flight test operations schedule for the Sikorsky S-76A consisted of two major parts.

The first part or core test program included the ICAO certification test operations (takeoff, approach, and level flyover) supplemented by level flyovers at various altitudes (at a constant airspeed) and at various airspeeds (at a constant altitude). In addition to the ICAO takeoff operation, a second, direct climb takeoff flight series was included. Alternative approach operations were also included, utilizing nine and twelve degree approach angles to compare with the six degree ICAO approach data.

The second part of the test program consisted of static operations designed to assess helicopter directivity patterns and examine ground-to-ground propagation.

The information presented in Table 7.1 describes the Hughes 500D test schedule by test series, each test series representing a group of similar events. Each noise event is identified by a letter prefix, corresponding to the appropriate test series, followed by a number which represents the numerical sequence of event (i.e., A1, A2, A3, A4, B5, B6,...etc.). In some cases the actual order of test series may not follow alphabetically, as a D1, D2, D3, D4, E5, E6, E8, H9, H10, H11,... etc.). In the case of static operations the individual events are reported by the acoustical emission angle referenced to each individual microphone location (i.e., J120, J165, J210, J255, J300, J345, J030, J75). In Table 7.1, the test target operational parameters for each series are specified along with approximate start and stop times. These times can be used to reference corresponding meteorological data in Appendix G. Timing of fuel breaks are also identified so that the reader can estimate changes in helicopter weight with fuel burn-off. Actual operational parameters and position information for specific events are specified in the appendices of this document.

Operations requiring a more detailed description are detailed below.

Test Series H: Identified by the manufacturer as a "Category B Takeoff" (see Code of Federal Regulations 14, Part 29), carried out in accordance with the following protocol:

Rotor RPM: 100%

Torque: 100%

Initial condition: Zero knots, hover-in-ground effect (5 feet above ground level), 700 meters before CLC.

Phase 1: Accelerate to 45 knots, climbing out

Phase 2: Upon reaching a marker 500 meters prior to CLC, achieve a rate of ascent of 1350 feet per minute maintaining 52 knots.

Test Series J: Identified by the manufacturer as "Takeoff with a turn", involved identical operation conditions as test series F (the ICAO takeoff operation) except with a 90 degree turn initiated directly over the centerline microphone location at CLC. The turn was to achieve a 20 degree bank angle with a continued climbout in the direction of sideline microphone number 3, extending well beyond that site.

Test Series O-1 (oh-one): Identified as "Quiet takeoff from centerline center (CLC)." This operation involved an initial 1-foot hover over CLC, the application of power, achieving 15 to 20% torque, accelerating to 15 feet, achieving translational lift, then acquiring the best rate of climb.

Test Series 0-2 (oh-two): Not to be confused with molecular oxygen, this test series was identified as a "Quiet Approach Operation"and conducted as a landing approach to the CLC microphone location, site 1. This test series was characterized by the following flight path parameters:

1. 2000 feet prior to CLC: 200 feet above ground level (AGL), 70 knots
2. 1000 feet prior to CLC: 100 feet AGL, 50 knots
3. 500 feet prior to CLC: 50 feet AGL, 30 knots
4. CLC site: terminate operation at a low hover

The noise measurement personnel and equipment were removed from site 1 prior to this test series

Figures 7.1, 7.2, and 7.3 present the test flight configurations for the takeoff, approach and level flyover operations. A schematic of the actual ground track in relation to measurement sites is shown in Figure 3.3.

TABLE 7.1

TEST SUMMARY

SIKORSKY S-76A

Test Series And Run Numbers	Description Of Series	Start Time	Finish Time
A/A1-A6	LFO, 500', Vne	6:06 am	6:20 am
B/B7-B13	LFO, 500', 0.9 Vne	6:23	6:37
C/C14-C18	LFO, 500', 0.8 Vne	6:40	7:00
D/D19-D23	LFO, 500', 0.7 Vne	7:06	7:16
E/E24-E28	LFO, 1000', Vne	7:27	7:38
F/F29-F36	ICAO Takeoff	7:46	8:07
	FUEL BREAK		
G/G37-G43	3 Deg App, 74 kts	8:59	9:25
H/H44-H49	Category B Takeoff	9:42	9:56
I/I50-I55	6 Deg App, 74 kts	10:02	10:25
J/J56-J60	Takeoff with Turn	10:31	10:50
K/K61-K66	9 Deg App, 74 kts	10:54	11:10
	FUEL BREAK		
L	HIGE	11:47	12:00
M	Flt Idle/Gnd Idle	12:02 pm	12:19 pm
	BREAK		
O_1	Quiet Takeoff	12:43	1:03
O_2	Quiet Approach	12:46	1:06

FIGURE 7.1

Helicopter Takeoff Noise Tests

The take-off flight path shall be established as follows:

a) the helicopter shall be established in level flight at the best rate of climb speed, V_y, $\pm$ 3 knots, of the maximum speed of the curve contignous to the ordinated of the limiting height-speed envelope + 3 knots ($\pm$3 knots), whichever is greater, and, at a height of 20 m (66 ft) above the ground until a point 500 m (1,640 ft) before the flight path reference point is reached;

b) upon reaching the point specified in a) above, the power shall be increased to maximum take-off power and a steady climb initiated and maintained over the noise measurement time period;

c) airspeed established in a) above shall be maintained throughout the take-off reference procedure;

d) the steady climb shall be made with the rotor speed stabilized at the maximum rpm for power-on operations

e) a constant take-off configuration selected by the applicant shall be maintained throughout the take-off reference procedure except that the landing gear may be retracted; and

f) the weight of the helicopter shall be the maximum take-off weight.

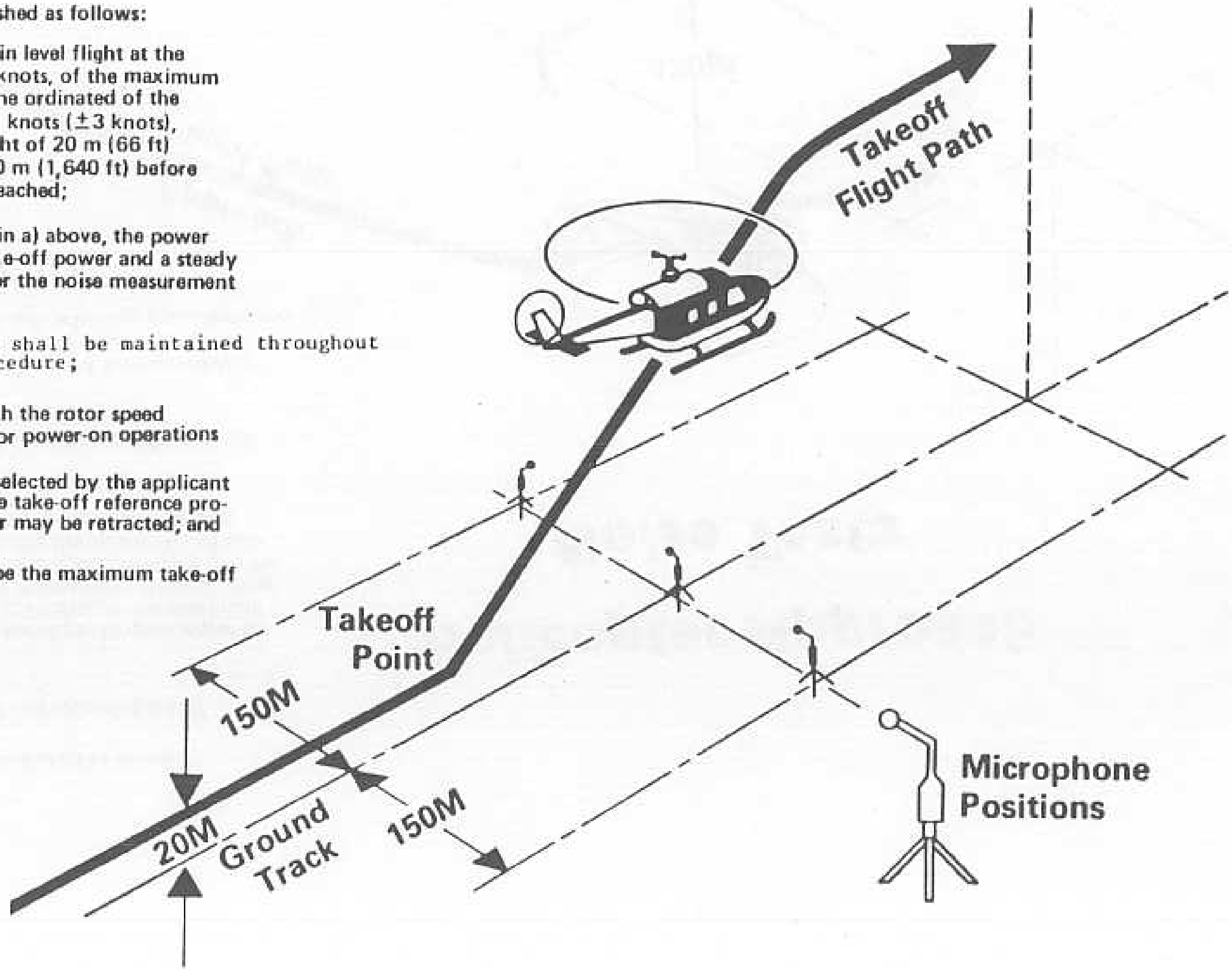


FIGURE 7.2

The approach procedure shall be established as follows:

a) the helicopter shall be stabilized and following a 6.0° approach path;

b) the approach shall be made at a stabilized airspeed equal to the best rate of climb speed V_y, ± 3 knots, or the maximum speed of the curve contiguous to the ordinate of the limiting height-speed envelope + 3 knots (± 3 knots), whichever is the greater, with power stabilized during the approach and over the flight path reference point, and continued to 50 feet above ground level

c) the approach shall be made with the rotor speed stabilized at the maximum rpm for power-on operations.

d) the constant approach configuration used in airworthiness certification tests, with the landing gear extended, shall be maintained throughout the approach reference procedure; and

e) the weight of the helicopter shall be the maximum landing weight

Helicopter Approach Noise Tests

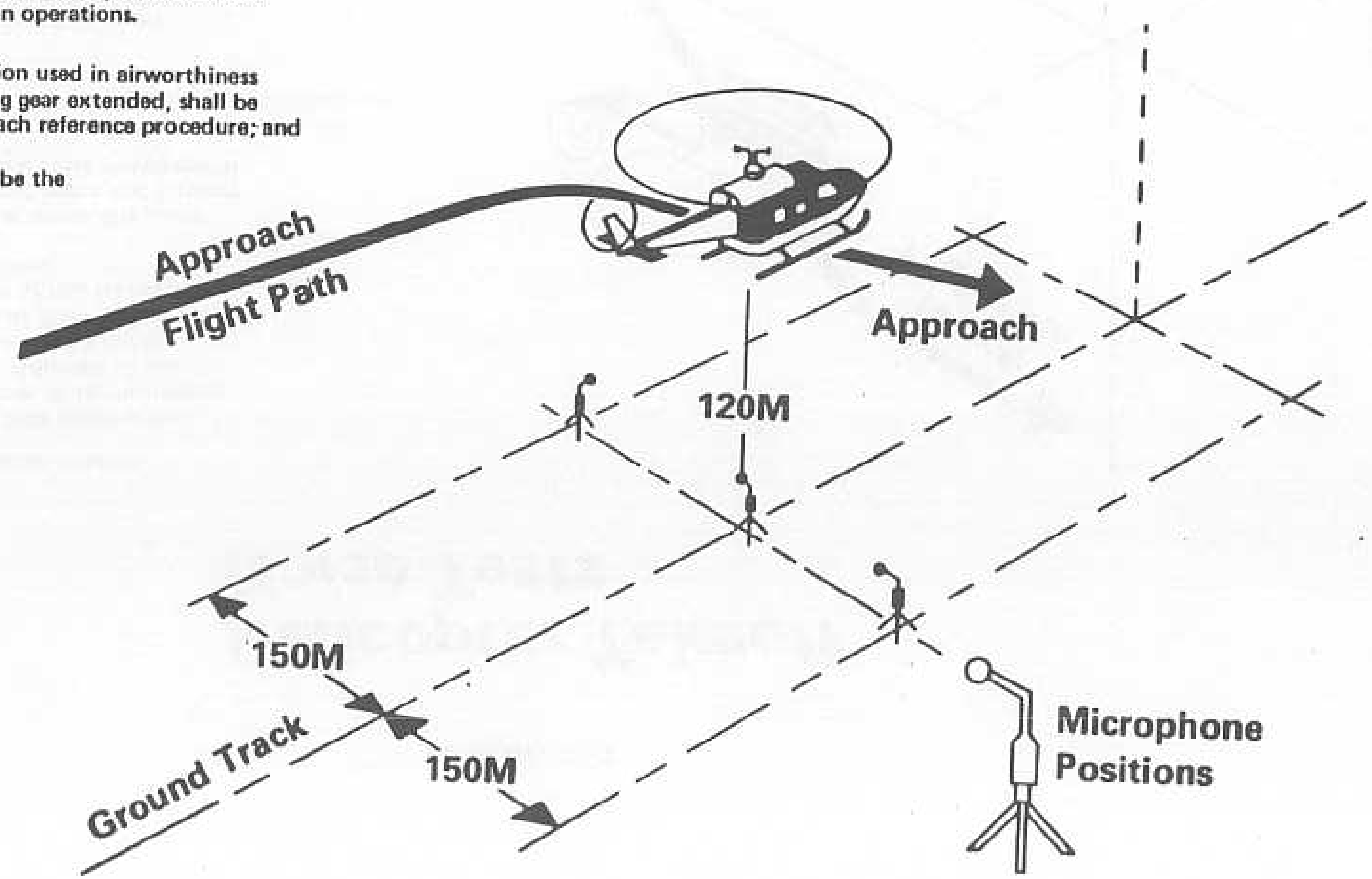


FIGURE 7.3

Helicopter Flyover Noise Tests

The flyover procedure shall be established as follows:

a) the helicopter shall be stabilized in level flight overhead the flight path reference point at a height of 150 m (492 ft);

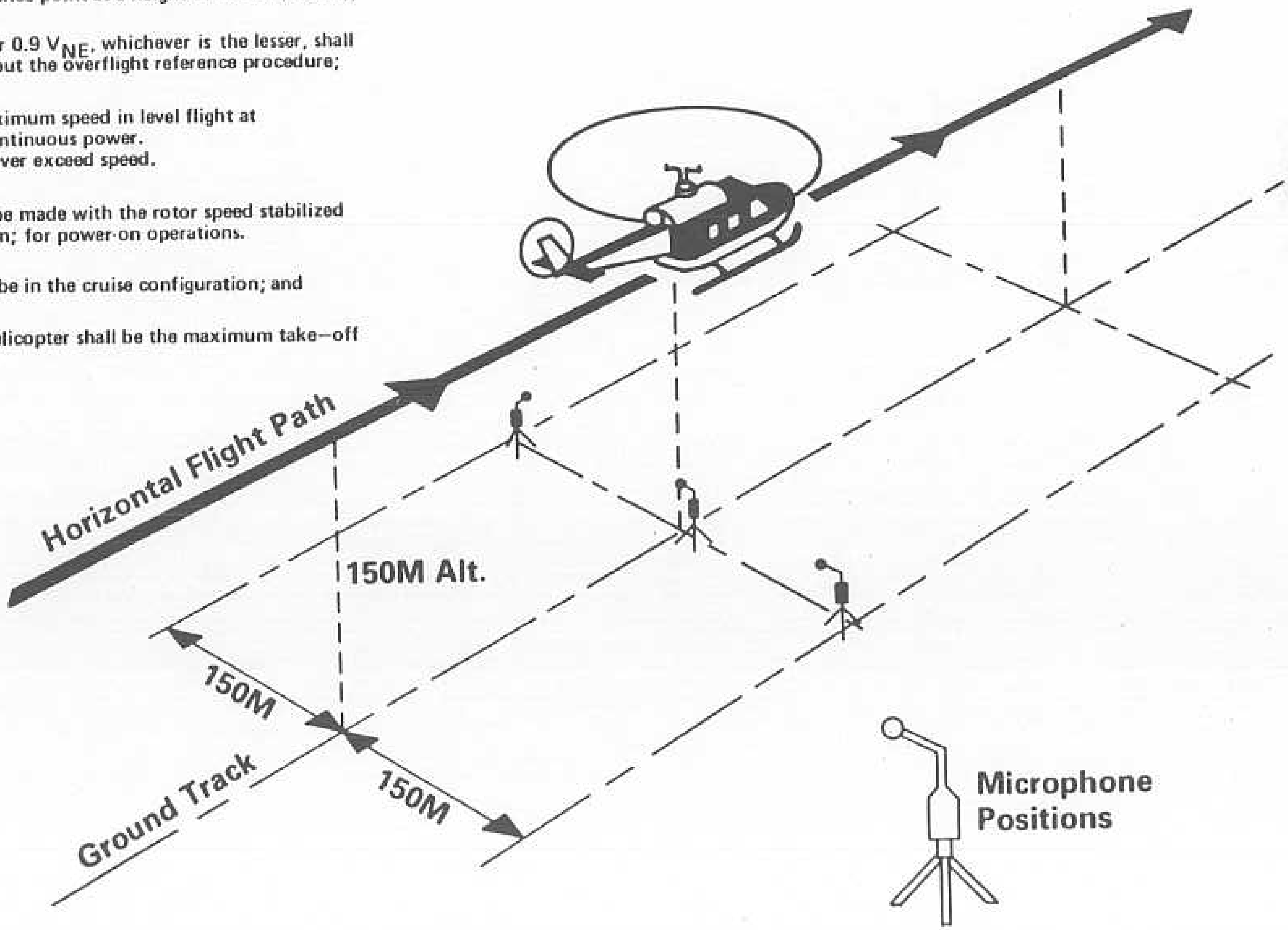
b) a speed of 0.9 V_H or 0.9 V_{NE}, whichever is the lesser, shall be maintained throughout the overflight reference procedure;

<u>NOTE</u>: V_H is the maximum speed in level flight at maximum continuous power.
V_{NE} is the never exceed speed.

c) the overflight shall be made with the rotor speed stabilized at the maximum rpm; for power-on operations.

d) the helicopter shall be in the cruise configuration; and

e) the weight of the helicopter shall be the maximum take–off weight.



8.0 Documentary Analyses/Processing of Trajectory and Meteorological Data - This section contains analyses which were performed to document the flight path trajectory and upper air meteorological characteristics during the Sikorsky S-76A test program.

8.1 Photo-Altitude Flight Path Trajectory Analyses - Data acquired from the three centerline photo-altitude sites were processed on an Apple IIe microcomputer using a VISICALC\ (manufacturer) electronic spreadsheet template developed by the authors for this specific application. The scaled photo-altitudes for each event (from all three photo sites) were entered as a single data set. The template operated on these data, calculating the straight line slope in degrees between the helicopter position over each pair of sites. In addition, a linear regression analysis was performed in order to create a straight line approximation to the actual flight path. This regression line was then used to compute estimated altitudes and CPA's (Closest Point of Approach) referenced to each microphone location (Note: Photo sites were offset from microphone sites by 100 feet). The results of this analysis are contained in the tables of Appendix F.

Discussion - While the photo-altitude data do provide a reasonable description of the helicopter trajectory and provide the means to effect distance corrections to a reference flight path (not implemented in this report), there is the need to exercise caution in interpretation of the data. The following excerpt makes an important point for those trying to relate the descent profiles (in approach test series) to resulting acoustical data.

In our experience, attempts by the pilot to fly down a very narrow VASI beam produce a continuously varying rate of descent. Thus while the mean flight path is maintained within a reasonable degree of test precision, the rate of descent (important parameter connected with blade/vortex interactions) at any instant in time may vary much more than during operational flying. (Ref. 8)

Further, care is necessary when using the regression slope and the regression estimated altitudes; one must be sure that the site-to-site slopes are similiar (approximate constant angle) and that they are in agreement with the regression slope. If these slopes are not in agreement, then use photo altitude data along with the site-to-site slopes in calculating altitude over microphone locations. Also included for reference are the mean values and standard deviations for the data collected at each site, for each series. These data display the variability in helicopter position within a given test series.

8.2 Meteorological Data - This section documents meteorological conditions including the coarse variation in upper air meteorological parameters as a function of time for the June 13 test program.

The National Weather Service office in Sterling, Virginia provided preliminary data processing resulting in the data tables shown in Appendix H. Supplementary analyses were then undertaken to develop time histories of various parameters over the period of testing for selected altitudes.

Each time history was constructed using least square linear regression techniques for the five available data points (one for each launch). The plots attempt to represent the gross (macro) meteorological trends over the test period. Paragraphs below point out some of the more salient features of each plot.

Temperature - Figure 8.1 shows the time history of temperature (°C) for June 13, 1983. It can be seen from the figure that a temperature inversion existed between the ground and the 500 foot level between 5:30 and 9:30 a.m., concurrent with the level flyover, takeoff and approach operations of this test. After 9:30 a.m., the inversion layer is seen to have dispersed, evidently due to solar heating of the earth's surface. At this time one observes a normal lapse rate of 1.5 to 2 C/1000 ft.

Static operations were conducted between 11:47 a.m. to 12:20 p.m., with additional takeoff/approach operations conducted between 12:43 and 1:06 p.m. Surface meteorological readings provided by the National Weather Service (Dulles International Airport) are available (see Appendix H) for analyses in connection with these operations.

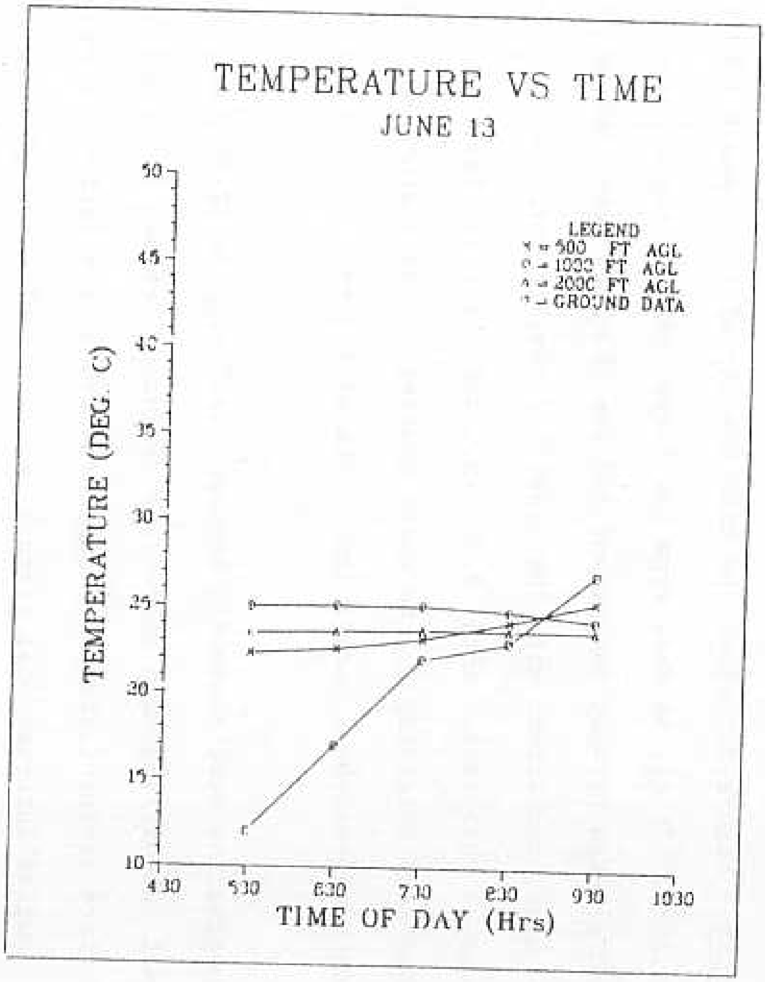


FIGURE 8.1

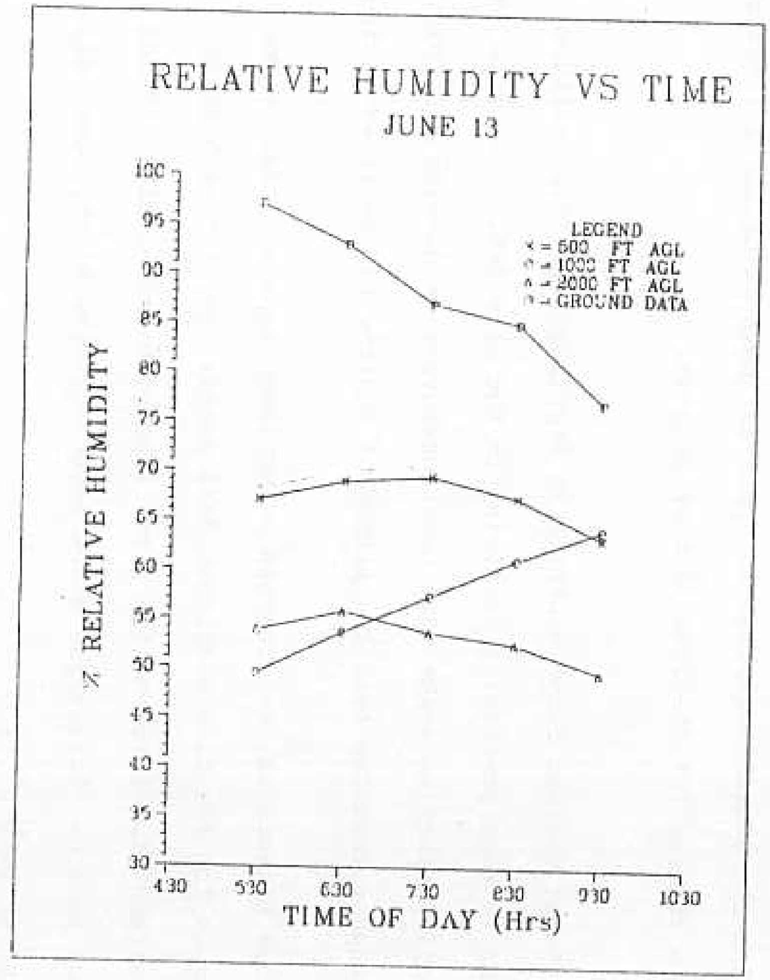


FIGURE 8.2

Discussion - In the context of a noise measurement/flight test one attempts to avoid so-called anomalous meteorological conditions, (see ref. 3) a concept that is difficult to define. Although the reasons behind the requirement to avoid "anomalous conditions" arose from concerns involved with atmospheric absorption, one might extend the requirement to include concerns for smooth flight, and normal attitudinal operation of the helicopter. While extreme cross wind components and/or strong shifts in wind in the vicinity of the test site might suggest the presence of buffeting or turbulance, it is primarily the pilot's reported ease or difficulty in flying the helicopter which identifies a potential problem. While the data do suggest the presence of some variation in wind speed and direction, they do not connote an extreme condition which might lead to concern.

As a final note, the influence of wind on blade-vortex interactions (considered a sensitive function) cannot be properly addressed using the data presented in this section. Rather, it is necessary to acquire detailed (time coded) data virtually concurrent with the flight operations and in very close proximity to the test helicopter. It is anticipated that future tests will employ tethered ballon systems or an acoustical sounding (SODAR) device deployed in close proximity to the test area.

HEAD/TAIL WIND

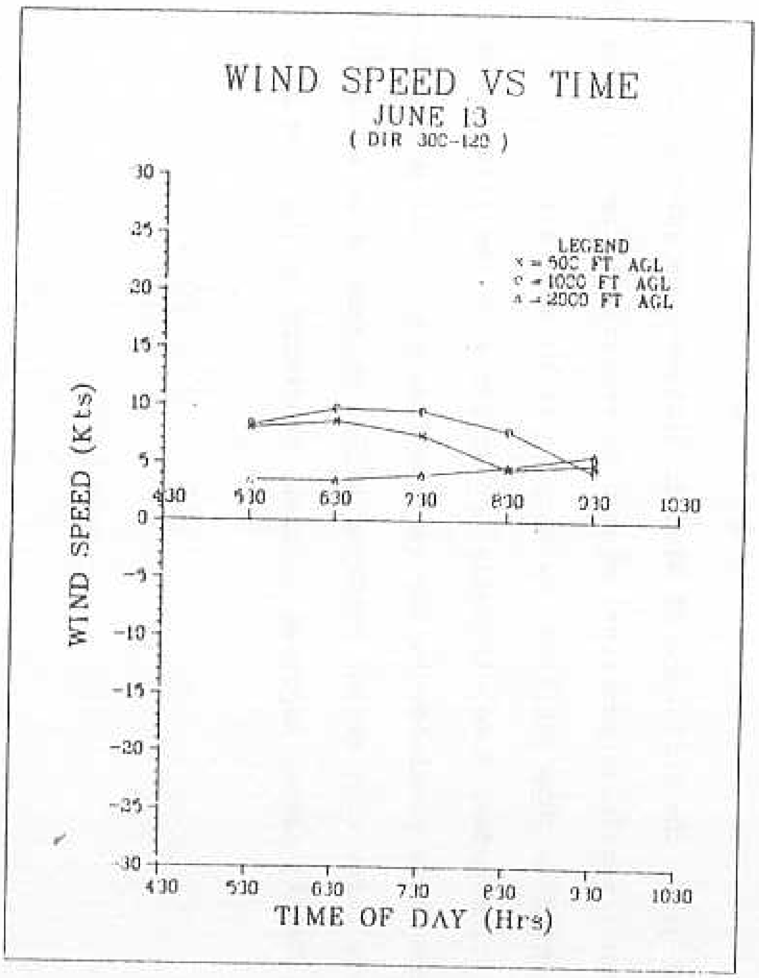


FIGURE 8.3

This plot indicates a headwind for operations in the 300 degree magnetic direction.

CROSS WIND

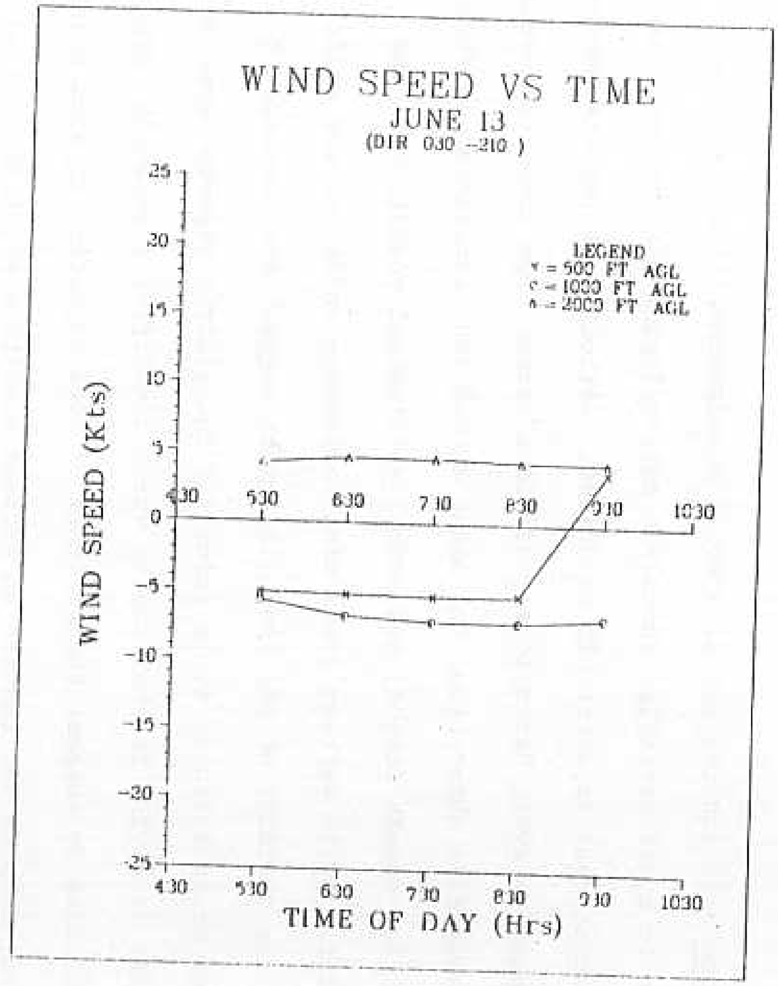


FIGURE 8.4

This plot indicates a right side crosswind for operations in the 120 degree magnetic direction.

Relative Humidity - Figure 8.2 shows the relative humidity (%) as a function of time for June 13, 1983. From the figure it is seen that the surface moisture decreases with time as expected with solar heating of the earth's surface. Attention is directed to the high relative humidity corresponding to the period of the temperature inversion. At 9:30 a.m. the relative humidity at the ground level is 20 to 25% higher than at the 500 foot level. From additional meteorological data provided by the National Weather Service, we see that by noon the surface relative humidity had decreased from 78% to 59%. The emphasis in examing relative humidity is in establishing atmospheric absorption coefficients for eventual correction of noise levels. An interesting trend is observed in ARP-866A concerning the test atmospheric absorption. For temperatures greater than 50 F and himidity greater than 5%, there is virtually no change in absorption with variation in relative humidity at frequencies below 630 Hz, typically dominant in rotorcraft spectra.

Wind - Figures 8.3 and 8.4 show the head/tail and cross wind components of the wind vector as a function of time for June 13. Figure 8.3 shows that head/tail winds of 7 knots were present at the 500 foot level, influending level flyover, takeoff and approach operations conducted during this time. See Appendix F, the cockpit data, to identify direction of travel. Additional meteorological data show that ground winds were about 7 knots up to 12 noon. Figure 8.4 also shows that up to the 1000 foot level, the magnitude of the crosswind was about 7 knots. This information shows that generally consistent wind conditions existed during the test period. Further, there were no pilot reports of turbulence or difficulty in managing flight controls.

Measurement Team:

1980 - FAA/TSC (also data reduction)

1983 - FAA/TSC (also data reduction)

1984 - FAA/HAI

Temperature:

1980 - 63 F/5 am, 62/5:30 am, 62/6 am, 65/7 am

1983 - 63 F/6 am, 70/7 am

1984 - 56 at 7 am, 60/8 am, 66/9 am, 70/10:15 am, 72/10:30 am

Relative Humidity:

1980 - 79/5 am, 81/5:30 am, 85/6 am, 83/6:30 am, 79/7 am

1983 - 95/6 am, 95/6:30 am, 95/7 am

1984 - NA for June 4

Temperature Inversion:

1980 - 4 degrees at 500 Ft. AGL

1983 - 10 degrees at 500 ft. AGL

1984 - NA

Wind Conditions:

1980 - 5 am: Right Cross = NA
Head/Tail = NA
Total Wind = 12 kts 500′ AGL

5:30: Right Cross = 3.8 kts at 500′ AGL
Head/Tail = 18 kts "
Total Wind = 19 kts "

6 am: Right Cross = 6.5 kts at 500′ AGL
Head/Tail = 21 kts "
Total Wind = 22 kts "

6:30 Right Cross = 8 kts at 500′ AGL
Head/Tail = 14 kts "
Total Wind = 15.8 kts "

7 am: Right Cross = 9.8 kts at 500′ AGL
Head/Tail = 13 kts "
Total Wind = 16 kts "

1983 Magnetic Recording Data - The magnetic recording data from the 1983 program (contained in appendicies of this report) was averaged for each test series and then position corrected using information acquired from the photo-altitude systems. In each case the mean noise level for a given test series was corrected using the corresponding mean altitude. The resulting corrected noise levels for each of the three microphones were averaged and the aggregate mean value was plotted verses the corresponding mean indicated airspeed gleaned from cockpit photographs. The propagation constant (KP(A)=25) used in the correction process was determined in section 9.7 of this document.

1984 Direct Read Data - The 1984 direct read data were acquired from a single direct read PISLM system and for a single airspeed and are uncorrected, although as observed above, corrections are typically very small for the 500 foot level flyover operation. The data point representing this data set is the mean value for a set of 12 events.

Table 9.2, below, identifies other pertinent flight test information.

Comparison of 1980 and 1983 500 Ft Level Flyover Results - The data plotted in Figure 9.1 and 9.2 have been processed as described above. While further statistical processing (analysis of variance and analysis of covariance) would be appropriate in a comprehensive repeatability analysis (subject of a future study) one can see a very definite and consistent differential of approximately 2 dB between the 1980 results and the results acquired in 1983.

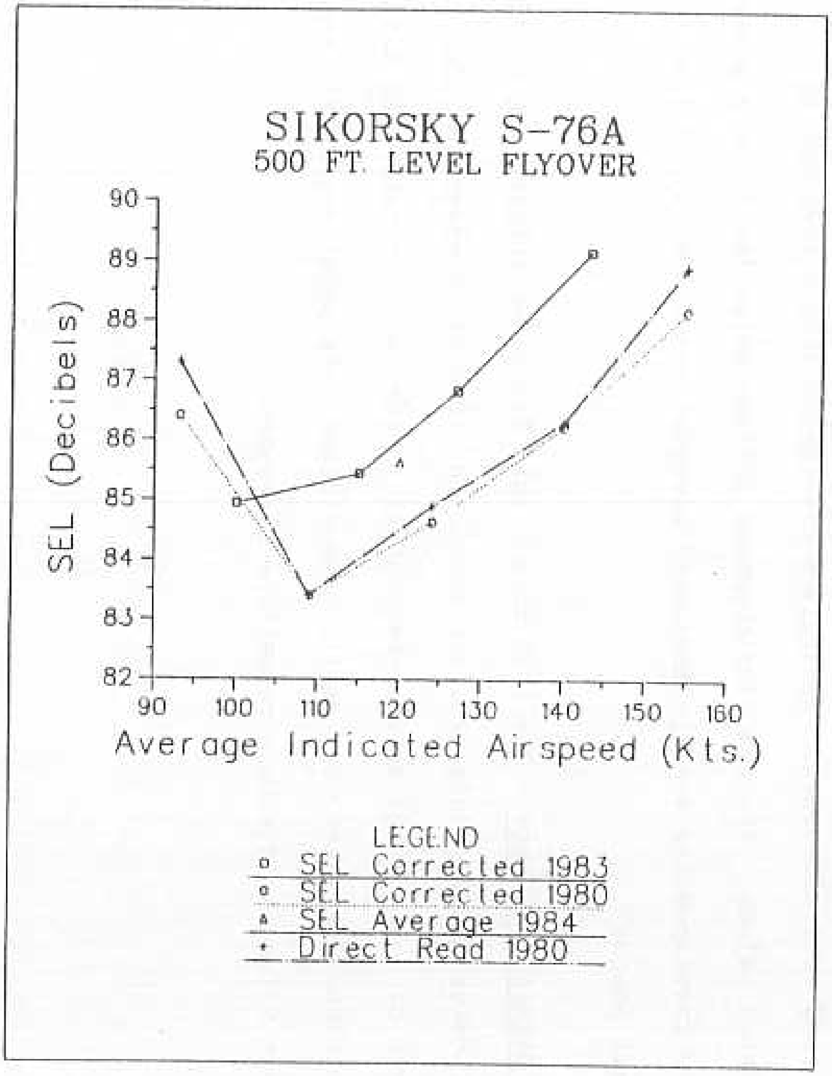


FIGURE 9.1

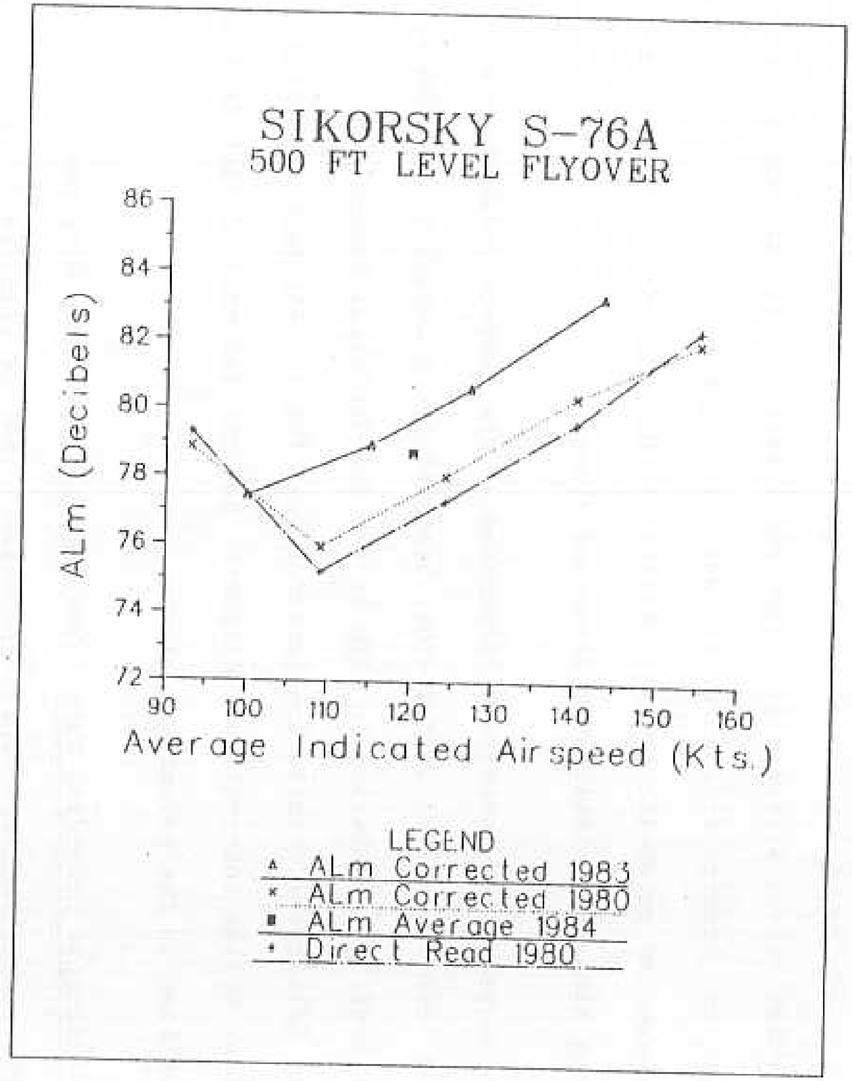


FIGURE 9.2

The noise versus airspeed plots for the Sikorsky S-76A are shown for two acoustical metrics in Figures 9.1 and 9.2. Each of these plots displays the expected parabolic nature, reflecting the influence of the noise versus airspeed relationship discussed above.

This section also contains a comparison of the subject noise data with sound levels acquired in two other tests of the Sikorsky S-76A, one an FAA test (Ref. 14) conducted in 1980 at the FAA Technical Center, the other a Joint Helicopter Association International (HAI) / FAA test conducted in 1984 at Dulles International Airport. Salient features of each test are identified in the paragraphs below.

1980 Magnetic Recording Data - The 1980 magnetic recording noise data used in the comparison were "fully corrected", that is adjusted for test flight path divergence from the reference flight path, (using photo-theodolite data) and test atmospheric absorption divergence from corresponding reference values. The 1980 3-microphone average noise levels were plotted verses corresponding average indicated airspeed values (attained from cockpit photos).

1980 Direct Read Data - The 1980 direct read Precision Integrating Sound Level Meter (PISLM) data were not corrected. One may however consider the absence of corrections as inconsequential as the magnetic recording data corrections were very very small. The plotted data point represents the average value for a single centerline microphone.

9.1 <u>Variation in Noise Levels with Airspeed for Level Flyover Operations and Comparison of Test Results</u> - It has been observed that as a helicopter increases its airspeed, two acoustically related events take place. First, the noise event duration is decreased as the helicopter passes more quickly. Second, the source acoustical emission characteristics change. These changes reflect the aerodynamic effects which accompany an increase in speed. At speeds higher than the speed for minimum power, the power required (torque) increases with an increase in airspeed. These influences lead to a noise intensity versus airspeed relationship generally approximated by a parabloic curve. At first, noise levels decrease with airspeed, then an upturn occurs as a consequence of increasing advancing blade tip Mach number effects, which in turn generate impulsive noise.

For the other helicopters tested (see Refs. 9, 10, 11, 12, 13), it has been observed that noise increases rapidly when the Mach Number advances beyond 0.8. Table 9.1, shown below, gives the relationship between indicated airspeed and advancing tip Mach number (M_A) for the S-76A.

Table 9.1

IAS (KTS)	M_A
93	.73
110	.76
125	.78
140	.80
155	.82

EXPLORATORY ANALYSES AND DISCUSSIONS

9.0 Exploratory Analyses and Discussion - This section is comprised of a series of distinct and separate analyses of the data acquired with the Sikorsky S-76 test helicopter. In each analysis section an introductory discussion is provided describing pre-processing of data (beyond the basic reduction previously described), followed by presentation of either a data table, graph(s), or reference to appropriate appendices. Each section concludes with a discussion of salient results and presentation of conclusions.

The following list identifies the analyses which are contained in this section.

- 9.1 Variation in noise levels with airspeed for level flyover operations
- 9.2 Static data analysis: source directivity and hard vs. soft propagation characteristics
- 9.3 Duration effect analysis
- 9.4 Analysis of variability in noise levels for two sites equidistant over similar propagation paths
- 9.5 Variation in noise levels with airspeed and rate of descent for approach operations
- 9.6 Analysis of ground-to-ground acoustical propagation for a nominally soft propagation path
- 9.7 Air-to-ground acoustical propagation analysis

1983 - 6:30 am: 300-120 degree heading = 8 kts at 500 AGL
030-210 degree heading = -5 kts "

7:30 am: 300-120 degree heading = 7 kts at 500 AGL
030-210 degree heading = -5 kts "

Rotor RPM:

1980 - 100%

1983 - 100%

1984 - 100%

Helicopter History/Maintenance Cycle:

1980 - Helicopter provided by Sikorsky Helicopter, belonging to Sikorsky Chief Executive Officer.

1983 - Helicopter provided by FAA Rotorcraft Program Office, involved in a broad range of FAA flight test activities. Same pilot participating in the 1980 test.

1984 - Helicopter provided by Sikorsky Aircraft, Sikorsky pilots, executive demonstrator.

Comparison of 1980 and 1983 1000 Ft Level Flyover Results - As a further point of exploration into the differences a comparison was made of the level flyover results for 1000 foot operations. Data from the 1980 and 1983 tests were processed as described above and the results are shown in Table 9.3 This table also includes a velocity correction to adjust the 1983 data (145 knots) to a velocity of 140 knots. In this instance one observes only a 1.2 dB difference in noise levels.

TABLE 9.3

Comparison of 1000 Ft LFO Noise Data

Test	IAS	Distance Corrected AL_M(dB)	Velocity Corrected AL_M(dB)
1984	120	72.3	75.3
1983	145	75.7	74.9
1980	140	73.7	73.7

Note: Velocity adjustment at a rate of 0.15 dB / Kt.

Relationship of 1984 Data to 1980 and 1983 Results - The 1984 500 foot points (one in each plot) tend to fall below but close (within 1 dB) to the 1983 data. The 1984 1000 foot data (measured at 120 knots) must be corrected to an airspeed of 140 knots before comparison with other data. Using a correction value of 3 dB/20 knots, one arrives at a corrected value of 75.3 dB, (see Table 9.3). This level compares well with the corrected 1983 value of 74.9 dB, (0.4 dB difference).

The reversal in relative loudness--1983 higher than 1984 at 500 feet with the opposite prevailing at 1000 feet--is believed to be a result of a higher attenuation rate during the 1983 test program as shown in Table 9.4. The diminution of the difference between the 1983 and 1980 results is believed to arise from ths same effect. A more thorough treatment of propagation is provided in Section 9.8 of this report. All things considered, the 1984 results tend to agree well with the 1983 data, as the graphs in Figures 9.1 and 9.2 show. Our attention therefore becomes directed to further exploration of differences between 1983 and 1980 results.

Table 9.4

Empirical Propagation Constants (AL)

	1984 (120 kts)	1980 (140 kts)	1983 (145 kts)
K	21.3	25.4	22.3

Note: See Section 9.7 for further discussion of propagation

Discussion

Examination of the factors outlined above does not lead one to any immediate, explanation for the 2 dB differences observed between 1980 and 1983 results.

It can be speculated that the source of disparity may be any one of the factors listed below:

1) track and balance of the rotor system

2) maintenance condition of the helicopter

3) "intrinsic" differences between differt models of the same helicopter type

It is not thought that "anomolous" atmospheric conditions can be cited as the cause, considering the reported stable meteorological data, the rather short slant distances involved (500 feet), the consistent differences over the time of testing at each different airspeed, and the internal consistencey (small variability) within each data set.

At the present time a Helicopter Noise Measurement Repeatability Program is being conducted by The International Civil Aviation Organization (ICAO). This program involves eight to ten different national measurement teams conducting noise tests on the same helicopter model, a Bell 206-L3. In the process of analyzing results of that program a more extensive analysis of these disparate S-76A results will be conducted.

9.2 Static Operations: Analysis of Source Directivity and Hard vs. Soft Path Propagation Characteristics - This analysis is comprised of two principal components. First, the plots shown in Figures 9.3 and 9.4 depict the time averaged directivity patterns for various static operations for measurement sites located equidistant from the hover point. The second component involves the fact that one of the two sites lies separated from the hover point by a hard concrete surface, while the other site is separated from the hover point by a soft grassy surface. The difference in the propagation of sound over the two disparate surfaces is reflected in the difference between the upper and lower curves in each plot. Figure 9.5 depicts the microphone positions and hard and soft paths in relation to the helicopter movement.

Time averaged (approximately 60 seconds) data are shown for acoustical emission directivity angles (see Figure 6.1) established every 45 degrees from the nose of the helicopter (zero degrees), in a clockwise fashion. Magnetic recording data plotted in these figures can be found in Appendix C for microphones 5H and 2.

Discussion - The plots contained in this analysis dramatically portray the directive nature of the S-76A acoustical radiation pattern for static operations.

Key points of interest include:

1. On the average the Ground Idle (GI) operation provides a 10dB benefit relative to the Flight Idle (FI) operation. The reduced RPM, GI mode epitomizes the concept of "Fly Neighborly" and is to be recommended for use in sensitive areas.

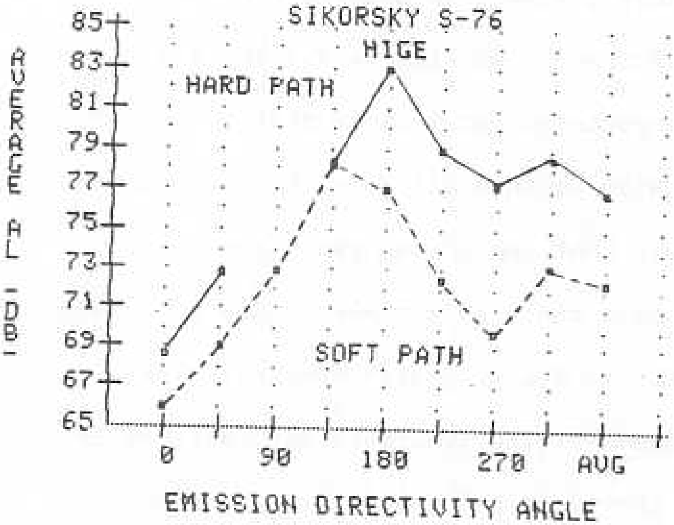


FIGURE 9.3

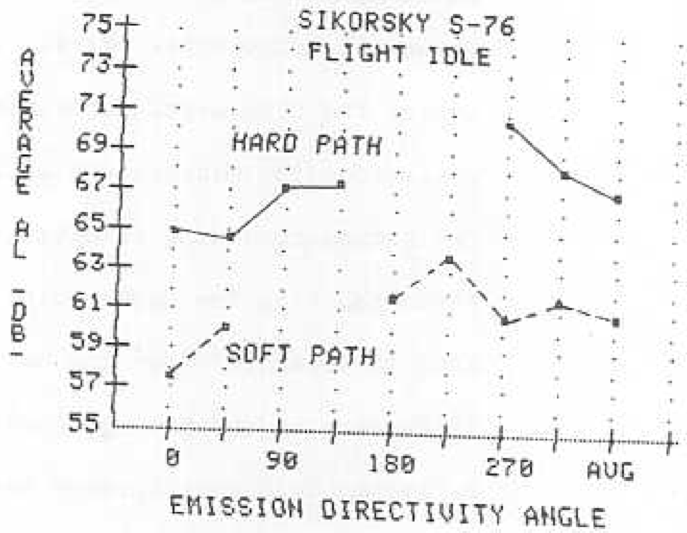


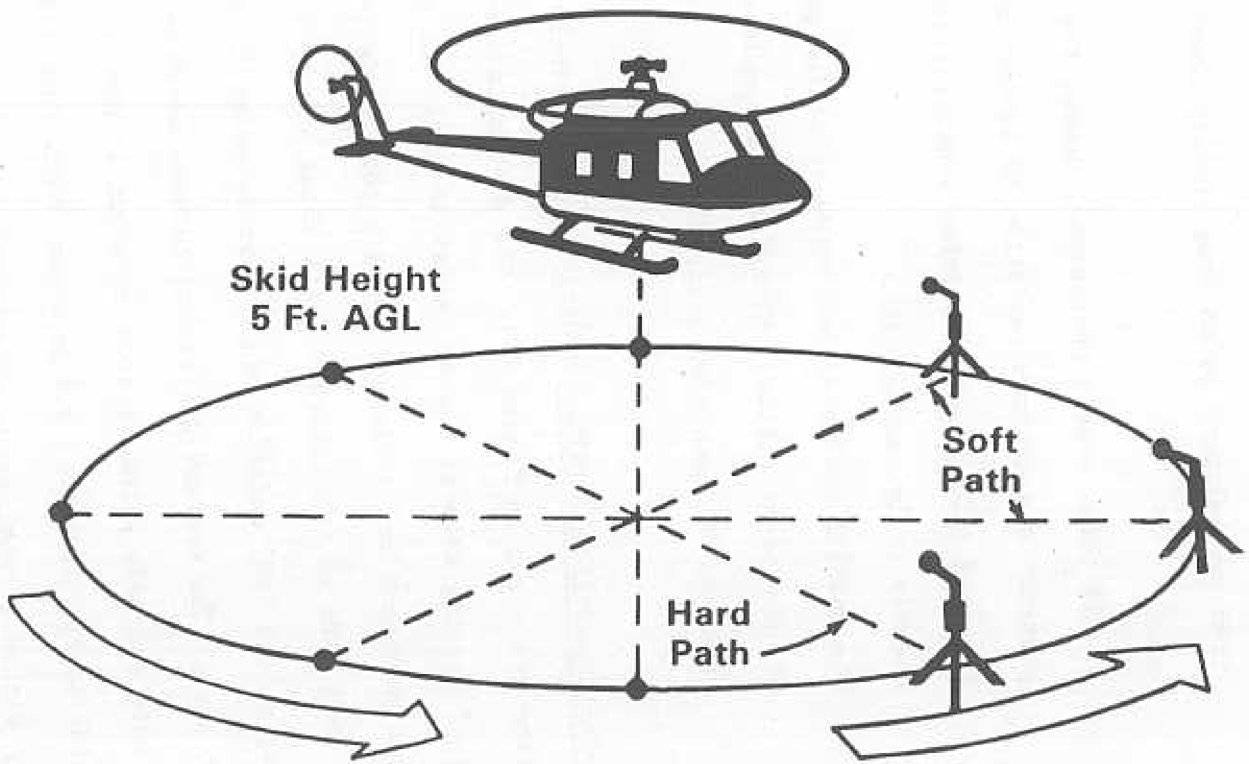
FIGURE 9.4

Flight Idle (FI) - Noise data for the Flat-Pitch Flight Idle (FI) operation are shown in Figure 9.4. Again we observe the left sided dominance of the acoustic radiation pattern. Identification of the emission angle where maximum noise levels occur is impossible because of the missing data nevertheless the general trends of the data are provided for the reader. On the average maximum differences between hard and soft sites are about 6 to 9 dB.

In each case discussed below, observations concerning noise impact and acceptability are based on consideration of typical urban/community ambient noise levels and the levels of urban transportation noise sources. In general, the interpretation of environmental impact requires careful consideration of the ambient sound levels in the vicinity of the apecific heliport under consideration.

FIGURE 9.5

Helicopter Hover Noise Test



Helicopter Rotates in 45° Steps

8 Microphone Positions

2. The soft path propagation scenario provides, on the average, a 4dB reduction in noise levels relative to the hard path scenario. Clearly there exists a significant advantage in situating heliports in locations where noise sensitive areas are separated from the heliport by an acoustically absorbent surface such as grass.
3. In all three static operational modes, the nose of the helicopter presents the minimum radiation of acoustical energy. Positioning the nose toward the most noise sensitive community locations is clearly to be recommended.
4. The spacial maxima of the noise radiation pattern for each mode of operations follow: HIGE/leftrear quadrant, FI/rightrear quadrant, GI/both rear quadrants.

Hover-In-Ground-Effect (HIGE) - Data for the Hover-In-Ground-Effect (HIGE) operation are shown in Figure 9.3. The discontinuties in the plot are a result of missing data at the 90° emission angle for site #2. The S-76 displays an acoustical radiation pattern that tends to be most prominent on the left side of the aircraft (tail rotor side), with the maximum noise occuring at the 180° emission angle corresponding to the tail and engine exhaust port. The maximum difference between noise levels propagated across hard and soft paths is seen to occur at the 270° emission angle (left side of the aircraft) and is about 9 dB. This left side dominance is possibly due to a combination of main rotor vortex interaction with the tail rotor.

The table below (Table 9.5) provides A-weighted noise level ranges and interpretations as an additional reference for the reader. Further information on noise impact is available in the psychoacoustic literature. A general summary of noise impact can be found in Ref. 15.

Table 9.5

A-Weighted Noise Level Ranges

60 dB	-	Urban ambient noise level
Mid 60's	-	Urban ambient noise level
70 dB	-	Noise level of minor concern
Mid 70's	-	Moderately intrusive noise level
80 dB	-	Clearly intrusive noise level
Mid 80's	-	Potential Problems due to noise
90 dB	-	Noise level to be avoided for any length of time.

9.3 Analysis of Duration Effects - This section consists of three parts, each developing relationships and insights useful in adjusting from one acoustical metric to another (typically from a maximum level to an energy dose). Each section quantitatively addresses the influence of the event duration.

9.3.1 Relationships Between SEL, AL and T-10 - This analysis explores the relationship between the helicopter noise event (intensity) time-history, the maximum intensity, and the total acoustical energy of the event. Our interests in this endeavor include the following:

1) It is often necessary to estimate an acoustical metric given only part of the information required.

2) The time history duration is related to the ground speed and altitude of a helicopter. Thus any data adjustments for different altitudes and speeds will affect duration time and consequently the SEL (energy metric). The requirement to adjust data for these effects often arises in environmental impact analysis around heliports. In addition, the need to implement data corrections in helicopter noise certification tests further warrants the study of duration effects.

Two different approaches have been utilized in analyzing the effect of event 10-dB-down duration (DURATION or T_{10}) on the accumulated energy dose (Sound Exposure Level).

Both techniques are empirical, each employing the same input data but using a different theoretical approach to describe duration influences.

The fundamental question one may ask is "If we know the maximum A-weighted sound level and we know the 10-dB-down duration time, can we with confidence estimate the acoustical energy dose, the Sound Exposure Level?" A rephrasing of this question might be: If we know the SEL, the AL, and the 10-dB-down duration time (DURATION), can we construct a universal relationship linking all three?

Both attempts to establish relationships involve taking the difference between the SEL and AL (delta), placing the delta on the left side of the equation and solving as a function of duration. The form which this function takes represents the differences in approach.

In the first case, one assumes that delta equals some constant K(DUR) multiplied by the base 10 logarithm of DURATION, i.e.,

$$SEL - AL = K(DUR) \times LOG(DURATION)$$

In the second case, we retain the 10 x LOG dependency, consistent with theory, while achieving the equality through the shape factor, Q, which is some value less than unity i.e., $SEL-AL = 10 \times LOG(Q \times DURATION)$. In a situation where the flyover noise event time history was represented by a step function or square wave shape, we would expect to see a value of Q equaling precisely one. However, we know that the time history for typical non-impulsive event is much closer in shape to an isosceles triangle and consequently likely to have a Q much closer to 0.5.

Another possible use of this analytical approach for the assessment of duration effects is in correcting noise certification test data which were acquired under conditions of nonstandard ground speed and/or distance.

Discussion - Each of the noise template data tables lists both of the duration related figures of merit for each individual event (see Appendix B). One immediate observation is the apparent insensitivity of the metrics to changes in operation, and the extremely small variation in the range of metric values, nearly a constant Q = 0.5 and a stable K(P) value of approximately 6.5. Data have been plotted in Figure 9.6 which show the minor variation of both metrics with airspeed for the level flyover operation for the microphone site 1 direct read system. The lack of variation in the parameters, suggests that a simple and nearly constant dependency exists between SEL, AL, and log DURATION, relatively unaffected by changes in airspeed, in turn suggesting a consistent time history shape for the range of airspeeds evaluated in this test. As SEL increases with airspeed, the increase appears to be related to increase in AL_M but mitigated in part by reduced duration time (and a nearly constant K(P)=6.5).

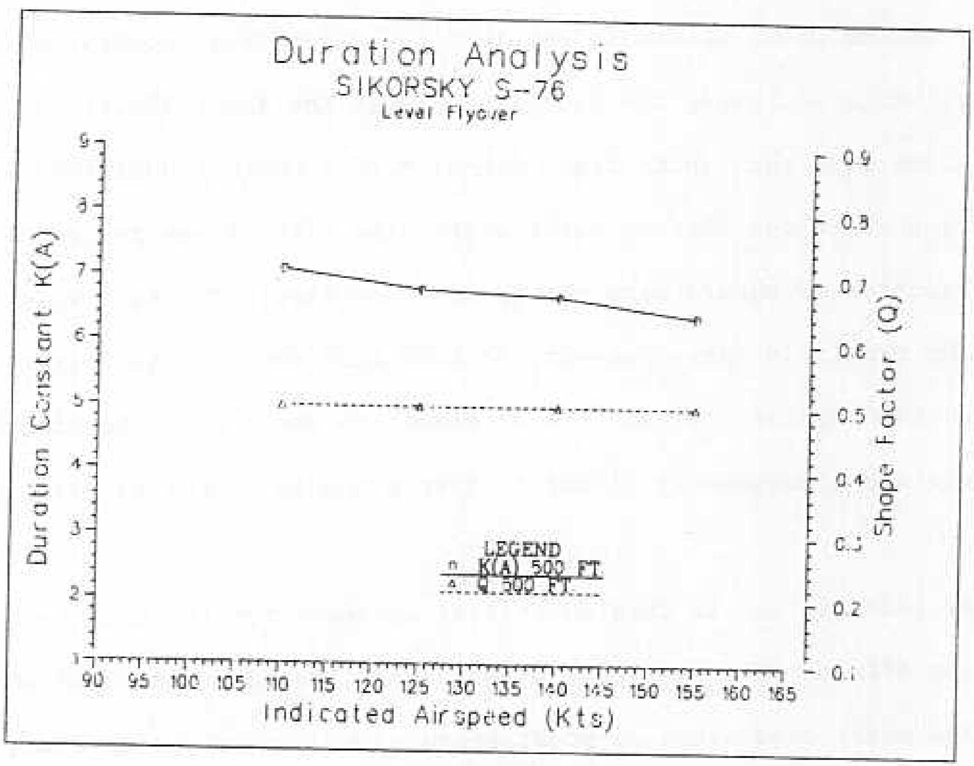


FIGURE 9.6

It is interesting to note that similar results were found for the other helicopters, (Ref. 9, 10, 11, 12, 13) suggesting that different helicopter models will have similar values for K and Q. This implies that it would not be necessary to develop unique constants for different helicopter models for use in implementing duration corrections. Caution is raised, however, to avoid drawing any firm conclusions. The possibility exists that this particular analytical technique lacks the sensitivity necessary to detect distance and speed functionality.

9.3.2 Estimation of 10 dB Down Duration Time - In some cases, one does not have access to 10 dB down duratin time (DURATION) information. A moderate to highly reliable technique for estimating DURATION for the Sikorsky S-76 is developed empirically in this section.

The distance from the helicopter to the observer at the closest point of approach (expressed in feet) divided by the airspeed (expressed in knots) yields a ratio, hereafter referred to as (D/V). This ratio has been compiled for various test series for microphone sites 1,2 and 3 and has been presented in Table 9.6 along with the average DURATION expressed in seconds. A linear regression was performed on each data set in Table 9.6 and those results are also displayed in Table 9.6. Here one observes generally high correlation coefficients, in the range of 0.64 to 0.80. The regression equations relating DURATION with D/V are given as

Centerline center, Microphone Site 1:
$T_{10} = [1.9 \times (D/V)] + 1.9$

Sideline South, Microphone Site 2:
$T_{10} = [1.4 \times (D/V)] + 3.7$

Sideline North, Microphone Site 3:
$T_{10} = [1.4 \times (D/V)] - 3.7$

TABLE 9.6

HELICOPTER: SIKORSKY S-76 DURATION (T-10) REGRESSION ON D/V

SITE 1

TEST SERIES	COCKPIT PHOTO DATA V AVG	AVG DUR(A)	AVG EST ALT	D/V
A	143.17	8.1	467.7	3.3
B	127	8.9	479	3.8
C	115	9.7	485.6	4.2
D	100	11.7	457.4	4.6
E	145	16.8	1037.8	7.2
F	78.5	10.9	399.7	5.1
G	77.5	9.3	387.4	5
H	65	12	444.2	6.8
I	74	10.7	364.3	4.9
J	75.25	10.9	372.7	5
K	74	17	406.7	5.5

LINEAR REGRESSION

SITE #1

SLOPE	1.9
INTERCEPT	1.88
R SQ.	.56
R	.75
SAMPLE	11

SITE 2

A	143.17	9.1	679	4.7
B	127	10.8	687	5.4
C	115	12.4	691.4	6
D	100	13.5	671.8	6.7
E	145	15.8	1148.6	7.9
F	78.5	14.1	634.7	8.1
G	77.5	13.8	626.8	8.1
H	65	14.5	633.5	9.7
I	74	15.5	612.2	8.3
J	75.25	14.4	617.7	8.2
K	74	19	638.4	8.6

LINEAR REGRESSION

SITE #2

SLOPE	1.38
INTERCEPT	3.66
R SQ.	.65
R	.8
SAMPLE	11

SITE 3

A	143.17	9.7	679.2	4.7
B	127	10.8	687.5	5.4
C	115	11.5	691.6	6
D	100	13.1	672.1	6.7
E	145	16.1	1149.5	7.9
F	78.5	13.5	626.4	8
G	77.5	17.8	623.5	8
H	65	13.8	658.4	10.1
I	74	14.3	607.6	8.2
J	75.25	15.8	623.1	8.3
K	74	22.2	630.2	8.5

LINEAR REGRESSION

SITE #3

SLOPE	1.43
INTERCEPT	3.75
R SQ.	.41
R	.64
SAMPLE	11

It is interesting to note that each relationship has a similar slope (identical equations for the sideline sites) but the sideline site equations exhibit intercept values approximately 2 units (seconds) greater than the centerline site equation. This demonstrates that sideline sites generally experience (for smaller D/V ratios) flyover time histories which are longer and less peaked than the centerline site for a given distance and velocity. Because the regression analyses were conducted for a population consisting of all test series (which involved the operations in both directions) it is not possible to comment on left-right side acoustical directivity of the helicopter.

In summary, one sees that knowledge of the helicopter distance and velocity will enable an observer to reasonably estimate the 10 dB down duration time.

Synthesis of Results - It is now possible to merge the results of Section 9.3.1 with the findings above in establishing a relationship linking (D/V) with SEL and AL. Given the approximation

$$SEL = AL + (10 \times LOG(0.5 \times DURATION))$$

it is possible to insert the computed value for T_{10} (DURATION) into the equation and arrive at the desired relationship.

It is worth noting that the general trend observed for the S-76A (longer sideline duration) agrees well with results for the Aerospatiale TwinStar (Ref. 12) and AStar (Ref. 13) but opposes the trend observed for the Hughes 500D (Ref. 11). It appears necessary to carefully consider helicopter specific characteristics in estimating SEL or other energy-dose acoustical metrics at sideline locations. It is significant to note that slopes computed above for the S-76A are generally similar (approximately 2) to those observed for the AStar, TwinStar and Hughes 500D, suggesting that a general relationship would do well in assessing changes or differentials in noise level with changes in either distance or velocity.

9.3.3 <u>Relationship Between SEL Minus AL and the Ratio D/V</u> - The difference between SEL and AL_M or conversely, EPNL and $PNLT_M$ (in a certification context) is referred to as the DURATION CORRECTION. This difference is clearly controlled by the event T_{10} (or 10 dB down duration time) and the acoustical energy contained within those bounds. As discussed in previous sections, the T_{10} is highly correlated with the ratio D/V. This analysis establishes a direct link between D/V and the DURATION CORRECTION in a manner similar to that employed in Section 9.3.2. Table 9.7 provides a summary of data used in regression analyses for microphones 1, 2 and 3. The regression equations, along with other statistical information, are provided in Table 9.7 also.

It is encouraging to note the generally strong correlations (coefficients greater than 0.67) which suggest that SEL can be estimated directly (and with confidence) from the AL_M and knowledge of D/V. It is also interesting to note the difference in regression equations. As mentioned in Section 9.3.2, it is difficult to comment explicitly (and quantitatively) on source directivity because operations were conducted in both directions. Regadless, one can see that centerline/sideline differences do exist.

TABLE 9.7

HELICOPTER: SIKORSKY S-76 SEL-ALm REGRESSION ON D/V

SITE 1

TEST SERIES	COCKPIT PHOTO DATA V AVG	AVG SEL-ALm	AVG EST ALT	D/V
A	143.17	5.8	467.7	3.3
B	127	6.4	479	3.8
C	115	6.7	485.6	4.2
D	100	7.5	457.4	4.6
E	145	9.1	1037.8	7.2
F	78.5	7.3	399.7	5.1
G	77.5	6.5	387.4	5
H	65	7.4	444.2	6.8
I	74	6.8	364.3	4.9
J	75.25	7.6	372.7	5
K	74	8.1	406.7	5.5

LINEAR REGRESSION

SITE #1

SLOPE	.64
INTERCEPT	3.96
R SQ.	.68
R	.82
SAMPLE	11

SITE 2

TEST SERIES	COCKPIT PHOTO DATA V AVG	AVG SEL-ALm	AVG EST ALT	D/V
A	143.17	6.6	679	4.7
B	127	7.3	687	5.4
C	115	7.6	691.4	6
D	100	8.1	671.8	6.7
E	145	9.1	1148.6	7.9
F	78.5	8	634.7	8.1
G	77.5	8.1	626.8	8.1
H	65	8.4	633.5	9.7
I	74	8.4	612.2	8.3
J	75.25	8.8	617.7	8.2
K	74	8.5	638.4	8.6

LINEAR REGRESSION

SITE #2

SLOPE	.38
INTERCEPT	5.26
R SQ.	.67
R	.82
SAMPLE	11

SITE 3

TEST SERIES	COCKPIT PHOTO DATA V AVG	AVG SEL-ALm	AVG EST ALT	D/V
A	143.17	7.1	679.2	4.7
B	127	7.4	687.5	5.4
C	115	7.5	691.6	6
D	100	7.8	672.1	6.7
E	145	8.8	1149.5	7.9
F	78.5	8.2	626.4	8
G	77.5	9.5	623.5	8
H	65	8.1	658.4	10.1
I	74	8.4	607.6	8.2
J	75.25	8.9	623.1	8.3
K	74	9.5	630.2	8.5

LINEAR REGRESSION

SITE #3

SLOPE	.36
INTERCEPT	5.63
R SQ.	.47
R	.69
SAMPLE	11

9.4 Analysis of Variability in Noise Levels for Two Sites Over Similiar Propagation Paths - This analysis examines the differences in noise levels observed for two sites each located 500 feet away from the hover point over similar terrain. The objective of the analysis was to examine variability in noise levels associated with ground-to-ground propagation over nominally similar propagation paths. The key word in the last sentence was nominally,...in fact the only difference in the propagation paths is that microphone 1H was located in a slight depression, (elevation is minus 2.5 feet relative to the hover point), while site 2 has an elevation of plus 0.2 feet relative to the hover point. This is a net difference of 2.7 feet over a distance of 500 feet. This configuration serves to demonstrate the sensitivity of ground-to-ground sound propagation over minor terrain variations.

Discussion - The results presented in Table 9.8 show the observed differences in time average noise levels for eight directivity angles and the spacial average. In each case, magnetic recording data (Appendix C) have been used in the analyses. It is observed that significant differences in noise level occur for this low angle (ground-to-ground) propagation scenarios.

It is speculated that very minor variations in site elevation (and resulting microphone placement) lead to site-to-site differences in the measured noise levels for static operations. Differences in microphone height result in different positions within the interference pattern of incident and reflected sound waves. It is also appropriate to consider whether variation in the acoustical source characteristics with time may

TABLE 9.8

COMPARISON OF
NOISE VERSUS DIRECTIVITY ANGLES
FOR
TWO SOFT SURFACES

HELICOPTER: SIKORSKY S-76

OPERATION: HOVER-IN-GROUND-EFFECT

	DIRECTIVITY ANGLES (DEGREES)								Lav(360 DEGREE)	
SITE	0	45	90	135	180	225	270	315	ENERGY	ARITH.
	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ
SOFT 1H	62	63.8	68.9	72.4	74.5	69	70.1	69	70.2	68.7
SOFT 2	66	69.1	72.9	78.2	77	72.5	69.8	73.2	73.9	72.3
DELTA dB	4	5.3	4	5.8	2.5	3.5	.3	4.2	3.7	3.6

* DELTA dB = (SITE 1H) minus (SITE 2)

contribute to noise level differences. In this analysis, magnetic recording data from microphone site 2 are compared with data recorded at site 1H approximately one minute later. That is, the helicopter rotated 45 degrees every sixty seconds, in order to project each directivity angle (there is a 45 degree separation between the two sites). In addition to source variation, it is also possible that the helicopter "aim," based on magnetic compass readings may have been slightly different in each case, resulting in the projection of different intensities and accounting for the observed differences. A final item of consideration is the possibility of refraction of sound waves (due to thermal or wind gradients) resulting in shadow regions. It is worth noting that, generally, similar results have been observed for other test helicopters (Bell 222, ref. 9; Aerospatiale Dauphin, ref. 10; Hughes 500D, Ref. 11; Aerospatiale TwinStar, Ref. 12; Aerospatiale AStar, Ref. 13). Regardless of what the mechanisms are which create this variance, one perceives that static operations display intrinsically variant sound levels, in both direction and time, and also potentially variant (all other factors being normalized) for two nominally identical propagation paths.

9.5 Variation in Noise Levels With Airspeed for 3, 6 and 9 Degree Approach Operations - This section examines the variation in noise level for variations in approach angle. Data are presented for 3, 6 and 9 degree approaches. The appropriate "As Measured" mean acoustical data contained in Appendix A, have been adjusted using factors presented in Table 9. 9 and plotted (corrected for the minor differences in altitude) in Figure 9.7 and 9.8.

This analysis has several objectives: first, to explore the realm of "Fly Neighborly" operating possibilities; second, to consider whether or not it is reasonable to establish a range of approach operating conditions for noise certification testing; and third, to compare results with data acquired during an extensive noise test conducted with the S-76A in 1980 (Ref. 14).

Discussion - In the approach operational mode, impulsive (banging or slapping) acoustical signatures are a result of the interaction between vortices (generated by the fundamental rotor blade action) colliding with successive sweeps of the rotor blades (see Figure 9.9). As reported in reference 16, for certain helicopters, maximum interaction occurs at airspeeds in the 50 to 70 knot range, at rates-of-descent ranging from 200 to 400 feet per minute. When the rotor blade enters the vortex region, it experiences local pressure fluctuations and associated changes in blade loading. These perturbations and resulting pressure gradients generate the characteristic impulsive signature.

The data presented in Figures 9.7 and 9.8 for the three centerline locations portray the variation in noise level as the approach angle (rate of descent) changes with airspeed held nominally constant. The potential benefit of using "Fly Neighborly" approach procedures is evident in the 4

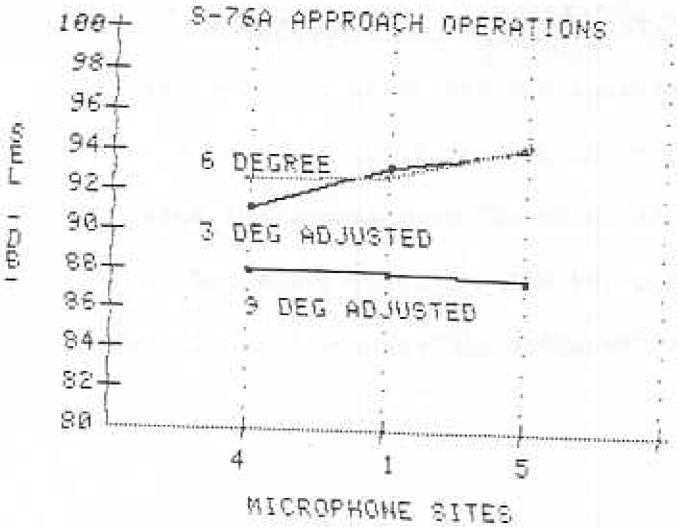


FIGURE 9.7

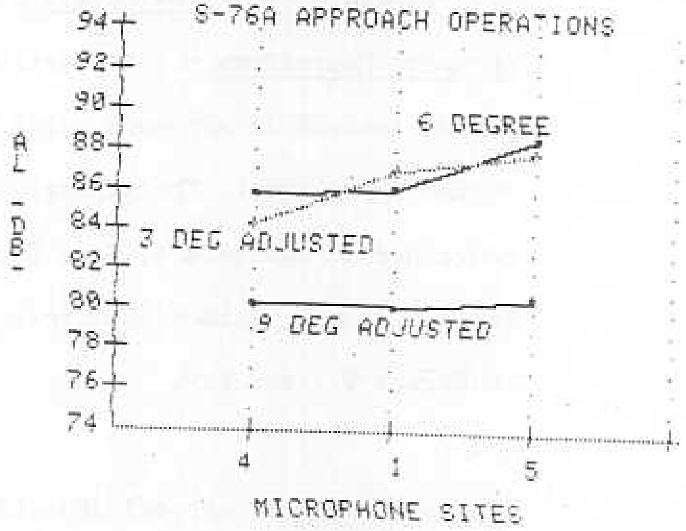


FIGURE 9.8

TABLE 9.9

SIKORSKY S-76A

APPROACH ADJUSTMENTS (dB)

	Site 4	Site 1	Site 5	Propagation Constant
9 Deg AL	1.6 dB	1.1 dB	0.04 dB	$K_A = 23$
9 Deg SEL	0.74 dB	0.77 dB	0.03 dB	$K_S = 16$
3 Deg AL	0.2 dB	0.62 dB	1.33 dB	$K_A = 23$
3 Deg SEL	0.12 dB	0.43 dB	0.93 dB	$K_S = 16$

The above adjustments are applied to "As Measured" noise levels to arrive at values used in Figures 9.8 and 9.9. All noise levels were corrected to the 6 degree reference altitudes (shown below).

Approach Altitudes	Site 4	Site 1	Site 5
6 Deg*	412.85	364.08	302.93
3 Deg**	420.27	387.41	346.20
9 Deg**	484.52	406.73	304.28

* Reference Altitude

**Average Test Altitudes

of descent) changes with airspeed held nominally constant. The potential benefit of using "Fly Neighborly" approach procedures is evident in the 4 to 5 dB differential between the 3 and 6 degree and the 9 degree data. It is interesting to note that "as measured" data reported in Reference 5 for the 6 degree approach operation agree quite well with the results of the subject test program. At microphone site 1, 1980 results revealed a mean AL of 85.2 dB and a mean SEL of 92.1 dB, whereas the 1983 tests showed an AL of 86.7 dB and an average SEL 92.6 dB.

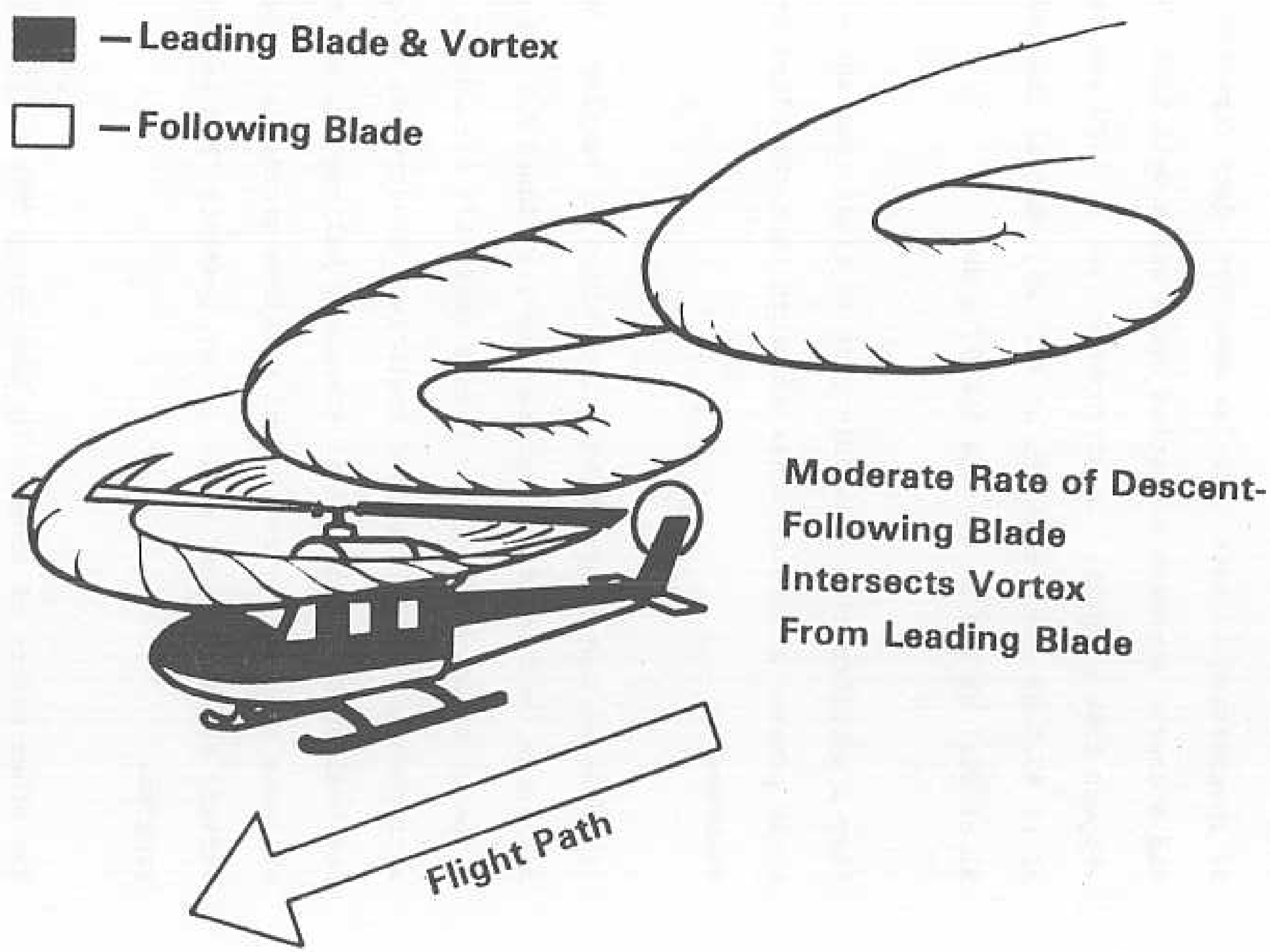
From a certification standpoint, it is clear that the 6 degree aproach would present a greater noise exposure than the alternative procedure examined.

It is noted that a more exhaustive series of testing would include 5 or 6 airspeeds (and additional microphone locations) for each approach angle. A recent study conducted in France (ref. 17) included a matrix of 24 microphones. While cost and logistical constraints make this unrealistic for evaluation of each civil transport helicopter, one would be prudent to evaluate several centerline and sideline microphone locations for a variety of operational modes in any in-depth "Fly Neighborly" flight test program.

Two other points of concern in developing "Fly Neighborly" procedures are safety and passenger comfort. Rates of descent, airspeed, initial approach altitude and "engine-out" performance are all factors requiring careful consideration in establishing a noise abatement approach.

FIGURE 9.9

Tip Vortex Interaction



Finally, while certain operational modes may significantly reduce noise levels, there may be an unacceptable acceleration /deceleration or rate-of-descent imposed on passengers. This clearly presents an important tradeoff to consider in any commercial air-shuttle operations.

9.6 Analysis of Ground-to-Ground Acoustical Propagation

9.6.1 Soft Propagation Path - This analysis involves the empirical derivation of propagation constants for a nominally level, "soft" path, a ground surface composed of mixed grasses. As discussed in previous analyses, there are several physical phenomena that influence the diminution of sound over distance. Among these phenomena, spreading loss, ground-to-ground attenuation and refraction are considered dominant in controlling the observed propagation constants.

A-weighted L_{eq} data for the four static operational modes- HIGE, HOGE, Flight Idle, and Ground Idle- have been analyzed in each case for eight different directivity angles. Direct read acoustical data from sites 2 and 4H have been used to calculate the propagation constants (K) as follows:

$$K = (\mathrm{Leq(site\ 2)} - \mathrm{Leq(site\ 4)})/\mathrm{Log}\ (2/1)$$

where the Log (2/1) factor represents the doubling of distance dependency (Site 2 is 492 feet and site 4H is 984 feet from the hover point).

For each mode of operation, the average (over various directivity angles) propagation constant has also been computed. The data used in this analysis (derived from Appendix C) are displayed in Table 9.10 and are summarized in Table 9.11.

TABLE 9.10

DATA UTILIZED IN COMPUTING EMPIRICAL
PROPAGATION CONSTANTS (K)
FOR SOFT SITES
4H & 2

SIKORSKY S-76

6-13-83

SITE 4H

HIGE		FLT.IDLE		GRN.IDLE	
L-0	54.40	M-0A	47.80	M-0B	49.60
L-315	62.70	M-315A	54.20	M-315B	NA
L-270	59.00	M-270A	52.20	M-270B	NA
L-225	63.20	M-225A	53.30	M-225B	NA
L-180	66.20	M-180A	53.00	M-180B	39.40
L-135	64.90	M-135A	NA	M-135B	NA
L-90	61.30	M-90A	NA	M-90B	NA
L-45	56.30	M-45A	50.10	M-45B	NA

SITE 2

HIGE		FLT.IDLE		GND.IDLE	
L-0	63.90	M-0A	57.10	M-0B	54.80
L-315	72.10	M-315A	61.50	M-315B	NA
L-270	69.60	M-270A	60.30	M-270B	NA
L-225	73.20	M-225A	62.80	M-225B	NA
L-180	76.10	M-180A	61.40	M-180B	45.20
L-135	77.00	M-135A	NA	M-135B	NA
L-90	71.80	M-90A	NA	M-90B	NA
L-45	67.90	M-45A	59.70	M-45B	NA

TABLE 9.11

SIKORSKY S-76

EMPIRICAL PROPOGATION CONSTANTS (K)
FOR SOFT SITES (4H+2)

EMISSION ANGLE	HIGE K	FLT.IDLE K	GND.IDLE K
0	31.67	31.00	17.33
315	31.33	24.33	
270	35.33	27.00	
225	33.33	31.67	
180	33.00	28.00	19.33
135	40.33		
90	35.00		
45	38.67	32.00	
AVERAGE	34.83	29.00	18.33

TABLE 9.12

Summary of Soft Path
Propagation Constants

Helicopter	Average HIGE K	Average FI K	Average GI K	Average HOGE K
Bell 222	41.20	22.30	13.90	9.10
Aerospatiale Dauphin 2	19.16	26.34		24.42
Hughes 500D	28.67	25.04	23.50	
Aerospatiale TwinStar	37.08	35.05	32.60	30.35
Aerospatiale AStar	37.87	36.12	23.33	
Sikorsky S-76A	34.83	29.00	18.33	
AVERAGE	33.14	28.98	22.33	21.66

Discussion - The results shown in Table 9.1 exhibit some minor variation from one operational mode to the next. The attenuation constants for HIGE and flight idle tend to agree well with results reported for other helicopters, being in the vicinity of 30 for the S-76A. The ground idle data are suspicious probably influenced by poor signal to noise conditions (also a very small sample size).

A summary of results for other helicopters is presented in Table 9.12. Although S-76A results are somewhat higher, the generalized relationship ΔdB = 25 log (d1/d2) provides a reasonable working approximation for calculating ground-to-ground diminution of A-weighted sound levels over nominally soft paths out to a distance of 1000 feet for the average helicopter.

9.6.2 Hard Propagation Path - This part of the analyses would involve the empirical derivation of constants for sound propagation over a "hard" propagation path, a concrete/composite taxi-way surface. The analytical methods described above (Section 9.6.1) are applicable using data from sites 5H and 7H, respectively 492 and 717 feet from the hover site. The salient feature of this scenario is the presence of a ground surface which is highly reflective and uniform in composition.

Discussion - The results of the analysis (not shown) revealed absurdly large propagation constant values. This outcome suggests a very high rate of attenuation between site 5H and 7H. The presence of a strong local temperature inversion (very low wind) is probably the source of difficulty, resulting in a shadow region beyond site 5H. It is evident that an isothermal condition with no wind would be the preferred condition for assessment of ground-to-ground propagation. If there is in fact significant shadowing (along the hard path), one may ask why the soft path scenario does not exhibit strange results as well. It can only be speculated that the hard asphalt surface controlled the temperature profile (and micrometeorology) in the vicinity of 5H and 7H. Conversely, the temperature profile in the vicinity of sites 2 and 4H may have differed significantly, perhaps controlled by the moist grassy surface. In essence, the rate of heat loss, the specific heat, and rate of heating for the dissimilar surfaces appear to have played a significant role in influencing the test results.

The "anomolous" result of propagation constants of approximately 50 (i.e., ΔdB = 50log (d1/d2) have now been observed for the hard path scenario for two other helicopters: Hughes 500D, (Ref. 11) and Aerospatiale AStar, (Ref. 13). In each case, one also observed static analyses for equidistant (150 m) hard and soft paths displaying (see Section 9.2) in which hard path levels were always higher. The presence of a low loss rate propagation constant directly opposes those results. The only plausible explanation remains the influence of micro meteorology. Subsequent reports in this series will endeavor to further investigate hard path ground-to-ground propagation.

9.7 Air-to-Ground Acoustical Propagation Analysis - The approach and takeoff operations provided the opportunity to assess empirically the influences of spherical spreading and atmospheric absorption. Through utilization of both noise and position data at each of the three flight track centerline locations (microphones 5, 1, and 4), it was possible to determine air-to-ground propagation constants.

One would expect the propagation constants to reflect the aggregate influences of spherical spreading and atmospheric absorption. It is assumed that the acoustical source characteristics remain constant as the helicopter passes over the measurement array. In past studies (Ref. 9, 10, 11, 12, 13), it has been observed that this assumption is reasonably valid for takeoff and level flyover operations. In the case of approach, however, significant variation has been evident. Because of the spacial/temporal variability in approach sound radiation along the (1000 feet) segment of interest, approach data have not been utilized in estimating propagation constants. As a final background note relating to the assumption of source stability a helicopter would require approximately 10 seconds, travelling at 60 knots, to travel the distance between measurement sites 4 and 5.

In both the case of the single event intensity metric, AL, and the single event energy metric, SEL, the difference between SEL and AL is determined for each pair of centerline sites. The delta in each case is then equated with the base ten logarithm of the respective altitude ratio multiplied by the propagation constant (either KP(AL) or KP(SEL), the values to be determined.

TABLE 9.13

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: ICAO TAKEOFF
TARGET IAS=75 KTS

MIC. 5-4

EVENT NO.	KP(AL)	KP(SEL)
F29	NA	NA
F30	12.3	6.2
F31	16.9	9.1
F32	22.8	7.4
F33	18.5	7.4
F34	23.3	14.4
F35	21.6	11.6
F36	25.7	12.6
AVERAGE	20.2	9.8
STD. DEV	4.56	3.10
90% C.I.	3.35	2.28

TABLE 9.14

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: TAKEOFF

MIC. 5-4

EVENT NO.	KP(AL)	KP(SEL)
H44	31.9	19.4
H45	6.7	2.9
H46	-1.1	2.3
H47	-5.2	3.5
H48	32.7	17.8
H49	0	5.9
AVERAGE	10.8	8.6
STD. DEV	17.11	7.84
90% C.I.	14.08	6.45

TABLE 9.15

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: TAKEOFF
TARGET IAS=74 KTS

MIC. 5-4

EVENT NO.	KP(AL)	KP(SEL)
J56	NA	NA
J57	NA	NA
J58	25.7	21.2
J59	22.3	17
J60	22.6	12.6
AVERAGE	23.5	16.9
STD. DEV	1.91	4.30
90% C.I.	3.21	7.26

TABLE 9.16

Summary Table of Propagation Constants for Three Takeoff Operations

Operation	KP(AL)
ICAO Takeoff	20.2
Takeoff	10.8
Takeoff	23.5
AVERAGE	18.17

TABLE 9.17

Summary Table for the Takeoff Operation

Helicopter	Propagation Constant (K)
Bell 222	N/A
Aerospatiale Dauphin 2	20.67
Hughes 500D	21.15
Aerospatiale TwinStar	24.4
Aerospatiale AStar	21.9
Sikorsky S-76A	18.17
Average	21.26

Data have also been analyzed from the 500 and 1000 foot level flyover operations and the KP(AL) has been computed. In this case, data were pooled for all centerline sites (5, 1, and 4) in the process of arriving at the propagation constant.

The takeoff analyses are shown in Tables 9.13, 9.14 and 9.15 and are summarized in Table 9.16. Results of the level flyover calculations are presented in Table 9.18. The level flyover and takeoff analyses are also accompanied by a tabulation of results from five previous reports (Tables 9.17 and 9.19).

Discussion - In the case of takeoff data (Table 9.16) one observes a propagation constant of about 18, a value in good agreement with previous results shown in Table 9.17. This value suggests that either little absorption takes place over the propagation path or that the source frequency content is dominated by low frequency components, (relatively unaffected by absorption).

In the case of level flyover data (Table 9.18), one observes a value of approximately 29, also in good agreement with previous results shown in Table 9.19. The variability in level flyover propagation constants from one helicopter to the next (spanning a range of 20 to 30) is likely associated with disparate source frequency content, different absoprtion characteristics on the various test days and variation in absorption on any particular test day.

TABLE 9.18

SIKORSKY S-76A

LEVEL FLYOVER PROPAGATION--AL

OPERATION		MIC 5	MIC 1	MIC 4	AL WEIGHTED AVERAGE
500′ (0.9Vh)	N=	5	5	5	
	AVG AL=	83.7	83.7	84.5	83.97
	STD DEV=	.7	.3	.4	
1000′ (0.9Vh)	N=	5	5	5	
	AVG AL=	75	75.1	75.6	75.23
	STD DEV=	1.2	1.1	1.3	

K= $\triangle$dB / LOG(1039.67 / 470.53) $\qquad$ $\triangle$dB= 8.73

K= 8.73 / .3443082

K= 25.36

TABLE 9.19

SUMMARY FOR LEVEL FLYOVER OPERATION

AL METRIC

HELICOPTER	PROPAGATION CONSTANT (K)
BELL 222	21.08
AEROSPATIALE DAUPHIN 2	21.40
HUGHES 500D	20.81
AEROSPATIALE TWINSTAR	20.19
AEROSPATIALE ASTAR	18.77
SIKORSKY S-76A	25.36

AVERAGE = 21.27

Table 9.20 provides a brief examination of propagation for the EPNL acoustical metric, used in noise certification. Calculations show a constant of approximately 20, a value greater than the mean but in good agreement with other results summarized in Table 9.21. The reader may consider computing propagation constants for other acoustical metrics as the need arises.

TABLE 9.20

SIKORSKY S-76A

LEVEL FLYOVER PROPAGATION--EPNL

OPERATION		MIC 5	MIC 1	MIC 4	EPNL WEIGHTED AVERAGE
500' (0.9Vh)	N=	5	5	5	
	AVG EPNL=	92.2	92.5	93.1	92.60
	STD DEV=	.8	.1	.3	
1000' (0.9Vh)	N=	3	5	4	
	AVG EPNL=	86.1	86.5	86.6	86.43
	STD DEV=	1.1	.6	1.1	

K= ΔdB / LOG(1039.67 / 470.53

ΔdB= 6.17

K= 6.17 / .3443082

K= 17.91

TABLE 9.21

SUMMARY TABLE FOR EPNL

HELICOPTER	PROPAGATION CONSTANT (K)
BELL 222	14.33
AEROSPATIALE DAUPHIN 2	18.67
HUGHES 500D	14.80
AEROSPATIALE TWINSTAR	13.84
AEROSPATIALE ASTAR	13.14
SIKORSKY S-76A	17.91

AVERAGE = 15.45

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APPENDIX A

Magnetic Recording Acoustical Data and Duration Factors
for Flight Operations

This appendix contains magnetic recording acoustical data acquired during flight operations. A detailed discussion is provided in Section 6.1 which describes the data reduction and processing procedures. Helpful cross references include measurement location layout, Figure 3.3; measurement equipment schematic, Figure 5.4; and measurement deployment plan, Figure 5.7. Tables A.a and A.b which follow below provide the reader with a guide to the structure of the appendix and the definition of terms used herein.

TABLE A.a

The key to the table numbering system is as follows:

Table No. A. 1-1. I

Appendix No.

Helicopter No. & Microphone Location

Page No. of Group

Microphone No.	1	centerline-center
	1G	centerline-center(flush)
	2	sideline 492 feet (150m) south
	3	sideline 492 feet (150m) north
	4	centerline 492 feet (150m) west
	5	centerline 617 feet (188m) east

TABLE A.b

Definitions

A brief synopsis of Appendix A data column headings is presented.

EV	Event Number
SEL	Sound Exposure Level, the total sound energy measured within the period determined by the 10 dB down duration of the A-weighted time history. Reference duration, 1-second.
ALm	A-weighted Sound Level(maximum)
SEL-ALm	Duration Correction Factor
K(A)	A-weighted duration constant where:
	K(A) = (SEL-ALm) / (Log DUR(A))
Q	Time History Shape Factor, where:
	Q = $(10^{0.1(\text{SEL-ALm})}$ / (DUR(A))
EPNL	Effective Perceived Noise Level
PNLm	Perceived Noise Level(maximum)
PNLTm	Tone Corrected Perceived Noise Level(maximum)
K(P)	Constant used to obtain the Duration Correction for EPNL, where:
	K(P) = (EPNL-PNLTm + 10) / (Log DUR(P))
OASPLm	Overall Sound Pressure Level(maximum)
DUR(A)	The 10 dB down Duration Time for the A-weighted time history
DUR(P)	The 10 dB down Duration Time for the PNLT time history
TC	Tone Correction calculated at PNLTm

Each set of data is headed by the site number, microphone location and test date. The target reference condtions are specified above each data subset.

TABLE NO. A.4-1.1

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/ 9/84

SITE: 1 CENTERLINE - CENTER JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
TAKEOFF -- Target IAS 74 KTS (ICAO)													
F29	85.8	78.6	7.1	7.0	0.5	89.7	91.0	92.8	6.9	82.0	10.5	10.0	1.9
F30	86.8	79.3	7.5	7.1	0.5	90.6	91.5	93.6	6.8	82.3	11.5	10.5	2.1
F31	87.6	79.8	7.8	7.3	0.5	91.2	92.1	94.2	6.8	82.6	11.5	10.5	2.1
F32	86.2	78.5	7.7	7.2	0.5	90.1	91.1	92.7	7.2	82.4	11.5	10.5	2.0
F33	86.6	79.5	7.0	6.9	0.5	90.7	92.0	94.2	6.6	82.7	10.5	9.5	2.3
F34	85.9	78.9	7.1	6.8	0.5	90.1	91.1	93.5	6.8	82.1	11.0	9.5	2.4
F35	86.2	79.7	6.5	6.5	0.4	90.5	92.2	94.1	6.7	82.9	10.0	9.0	2.3
F36	86.2	78.7	7.5	7.2	0.5	90.3	91.2	93.4	7.1	82.9	11.0	9.5	2.4
Avg.	86.4	79.1	7.3	7.0	0.5	90.4	91.5	93.6	6.9	82.5	10.9	9.9	2.2
Std Dv	0.6	0.5	0.4	0.3	0.0	0.5	0.5	0.6	0.2	0.3	0.6	0.6	0.2
90% CI	0.4	0.4	0.3	0.2	0.0	0.3	0.3	0.4	0.1	0.2	0.4	0.4	0.1
TAKEOFF -- CATERGORY B (SEE TEXT)													
H44	88.5	81.9	6.6	6.5	0.4	92.1	94.1	95.6	6.5	85.1	10.5	10.0	1.5
H45	88.4	81.6	6.9	6.7	0.5	91.8	93.7	95.4	6.4	84.3	10.5	10.0	1.7
H46	88.6	82.3	6.3	6.5	0.4	92.5	95.0	96.3	6.5	84.9	9.5	9.0	1.4
H47	87.0	78.3	8.7	7.3	0.5	90.6	90.8	92.4	7.5	81.6	16.0	12.0	2.0
H48	86.6	78.5	8.1	7.5	0.5	90.4	91.0	92.7	7.4	82.8	12.0	10.5	1.7
H49	86.6	79.0	7.6	6.7	0.4	90.3	91.3	93.2	6.6	81.6	13.5	12.0	1.7
Avg.	87.6	80.3	7.4	6.9	0.5	91.3	92.7	94.3	6.8	83.4	12.0	10.6	1.7
Std Dv	1.0	1.9	0.9	0.4	0.0	1.0	1.8	1.7	0.5	1.6	2.4	1.2	0.2
90% CI	0.8	1.5	0.8	0.4	0.0	0.8	1.5	1.4	0.4	1.3	2.0	1.0	0.2
TAKEOFF (WITH TURN) -- TARGET IAS 74 KTS													
J56	88.4	80.4	8.0	7.6	0.6	92.2	92.6	94.7	7.2	86.2	11.0	11.0	2.1
J57	86.6	78.6	8.1	7.6	0.6	90.2	90.7	92.7	7.4	83.5	11.5	10.5	2.0
J58	87.0	79.2	7.7	7.4	0.5	90.6	91.8	93.8	6.6	83.0	11.0	10.5	2.1
J59	86.8	79.6	7.2	6.9	0.5	90.5	92.1	93.7	6.8	82.4	11.0	10.0	1.7
J60	88.0	80.8	7.2	7.2	0.5	91.9	93.3	95.4	6.7	84.2	10.0	9.5	2.1
Avg.	87.3	79.7	7.6	7.4	0.5	91.1	92.1	94.1	6.9	83.9	10.9	10.3	2.0
Std Dv	0.8	0.9	0.4	0.3	0.0	0.9	1.0	1.0	0.3	1.5	0.5	0.6	0.2
90% CI	0.7	0.9	0.4	0.3	0.0	0.9	0.9	1.0	0.3	1.4	0.5	0.5	0.2

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.4-1.2

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/ 9/84

SITE: 1 CENTERLINE - CENTER JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
3 DEGREE APPROACH -- TARGET IAS 74 KTS													
G37	94.0	87.6	6.4	6.9	0.5	97.4	100.4	101.1	6.7	96.6	8.5	8.5	0.7
G38	94.7	88.8	5.9	6.0	0.4	97.3	101.2	101.7	5.9	97.9	9.5	8.5	0.5
G39	92.2	86.4	5.8	6.6	0.5	95.8	98.8	99.6	6.8	95.8	7.5	8.0	0.8
G40	91.1	85.8	5.4	6.4	0.5	-	98.5	99.6	-	94.9	7.0	-	1.0
G41	95.5	88.9	6.6	7.1	0.5	98.1	101.3	102.0	6.6	97.5	8.5	8.5	0.7
G42	92.6	85.3	7.3	6.9	0.5	95.7	98.1	98.9	6.7	95.4	11.5	10.5	0.8
G43	90.1	82.2	7.9	7.2	0.5	93.0	94.3	95.0	7.3	90.8	12.5	12.5	0.8
Avg.	92.9	86.4	6.5	6.7	0.5	96.2	99.0	99.7	6.7	95.6	9.3	9.4	0.8
Std Dv	1.9	2.3	0.9	0.4	0.0	1.8	2.4	2.4	0.4	2.3	2.0	1.7	0.2
90% CI	1.4	1.7	0.7	0.3	0.0	1.5	1.8	1.8	0.4	1.7	1.5	1.4	0.1
6 DEGREE APPROACH -- TARGET IAS 74 KTS													
I50	93.9	87.8	6.1	6.3	0.4	96.7	100.2	101.0	6.2	98.3	9.5	8.5	0.8
I51	91.9	83.7	8.1	6.8	0.4	95.3	97.1	97.8	7.2	94.6	15.5	11.0	0.6
I52	92.7	86.4	6.4	6.8	0.5	95.8	98.5	98.8	7.1	95.2	8.5	9.5	0.3
I53	93.6	86.8	6.9	6.6	0.4	96.9	99.9	100.8	6.2	96.5	11.0	9.5	0.9
I54	92.2	86.4	5.8	6.1	0.4	95.7	99.8	100.5	5.7	96.9	9.0	8.0	0.8
I55	93.0	85.6	7.4	7.3	0.5	96.2	98.3	99.0	7.3	94.9	10.5	10.0	0.7
Avg.	92.9	86.1	6.8	6.6	0.5	96.1	99.0	99.6	6.6	96.1	10.7	9.4	0.7
Std Dv	0.8	1.4	0.9	0.4	0.0	0.6	1.2	1.3	0.7	1.4	2.5	1.1	0.2
90% CI	0.7	1.1	0.7	0.4	0.0	0.5	1.0	1.1	0.6	1.2	2.1	0.9	0.2
9 DEGREE APPROACH -- TARGET IAS 74 KTS													
K61	84.1	77.2	6.9	6.9	0.5	-	89.5	90.0	-	88.8	10.0	-	0.5
K62	90.3	81.1	9.2	7.4	0.5	93.2	94.1	94.6	7.2	90.0	17.5	15.5	0.5
K63	88.0	79.1	8.9	6.5	0.3	91.6	92.8	94.0	5.8	89.2	23.5	21.0	1.1
K64	85.9	77.8	8.1	6.7	0.4	89.4	90.4	90.9	7.0	88.2	16.5	16.0	0.5
K65	87.5	80.5	7.0	6.1	0.3	91.0	93.7	94.3	6.4	89.9	14.5	11.0	0.6
K66	86.7	78.2	8.6	6.6	0.4	90.4	91.5	92.2	6.4	88.4	20.0	19.0	0.7
Avg.	87.1	79.0	8.1	6.7	0.4	91.1	92.0	92.7	6.6	89.1	17.0	16.5	0.7
Std Dv	2.1	1.6	0.9	0.4	0.1	1.4	1.8	1.9	0.6	0.8	4.6	3.8	0.2
90% CI	1.7	1.3	0.8	0.4	0.1	1.4	1.5	1.6	0.5	0.6	3.8	3.6	0.2

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.4-1.3

SIKORSKY S-76 HELICOPTER (SPIRIT)

DOT/TSC
5/ 9/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 1 CENTERLINE - CENTER JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 145 KTS													
A1	89.5	83.9	5.6	6.3	0.5	92.5	96.4	97.0	6.3	100.1	7.5	7.5	0.6
A2	89.7	83.8	5.9	6.4	0.5	92.7	96.4	97.0	6.3	98.4	8.5	8.0	0.6
A3	89.4	83.7	5.7	6.5	0.5	92.6	96.3	96.7	6.4	100.1	7.5	8.0	0.4
A5	89.2	83.2	5.9	6.4	0.5	92.3	95.8	96.5	6.2	99.3	8.5	8.5	0.7
A6	90.1	84.0	6.1	6.6	0.5	92.4	95.2	95.8	6.9	99.6	8.5	9.0	0.6
Avg.	89.6	83.7	5.8	6.4	0.5	92.5	96.0	96.6	6.4	99.5	8.1	8.2	0.6
Std Dv	0.3	0.3	0.2	0.1	0.0	0.1	0.5	0.5	0.3	0.7	0.5	0.6	0.1
90% CI	0.3	0.3	0.2	0.1	0.0	0.1	0.5	0.5	0.2	0.7	0.5	0.5	0.1
500 FT. FLYOVER -- TARGET IAS 130 KTS													
B7	86.0	79.8	6.2	6.8	0.5	-	92.1	93.1	-	94.9	8.0	-	1.0
B8	88.4	81.7	6.7	6.8	0.5	91.0	93.3	94.3	7.0	94.2	9.5	9.0	1.1
B9	86.3	79.6	6.8	6.8	0.5	89.2	91.7	92.7	6.8	93.1	10.0	9.0	1.0
B10	87.3	80.7	6.6	6.8	0.5	89.9	92.5	93.6	6.6	93.1	9.5	9.0	1.1
B11	87.4	81.4	6.0	6.5	0.5	90.2	93.6	94.4	6.4	95.2	8.5	8.0	0.8
B12	88.3	82.3	6.0	6.6	0.5	90.9	94.1	94.9	6.6	94.5	8.0	8.0	0.9
B13	85.5	79.0	6.5	6.8	0.5	88.4	91.1	92.1	6.6	92.9	9.0	9.0	1.0
Avg.	87.0	80.6	6.4	6.7	0.5	89.9	92.6	93.6	6.7	94.0	8.9	8.7	1.0
Std Dv	1.1	1.2	0.3	0.1	0.0	1.0	1.1	1.0	0.2	1.0	0.8	0.5	0.1
90% CI	0.8	0.9	0.2	0.1	0.0	0.8	0.8	0.7	0.1	0.7	0.6	0.4	0.1
500 FT. FLYOVER -- TARGET IAS 115 KTS													
C14	86.4	79.4	7.0	6.9	0.5	89.0	91.1	92.0	6.9	88.0	10.5	10.5	1.0
C15	85.7	79.3	6.4	6.7	0.5	88.8	91.4	92.7	6.6	87.4	9.0	8.5	1.1
C17	84.7	78.2	6.5	6.9	0.5	87.8	90.3	91.3	7.1	91.1	9.0	8.0	1.1
C18	86.7	79.9	6.9	6.7	0.5	89.6	91.8	92.8	6.7	89.3	10.5	10.0	1.0
Avg.	85.9	79.2	6.7	6.8	0.5	88.8	91.1	92.2	6.8	89.0	9.7	9.2	1.0
Std Dv	0.9	0.7	0.3	0.1	0.0	0.8	0.7	0.7	0.2	1.7	0.9	1.2	0.0
90% CI	1.0	0.8	0.3	0.1	0.0	0.9	0.8	0.8	0.3	2.0	1.0	1.4	0.1
500 FT. FLYOVER -- TARGET IAS 100 KTS													
D19	86.3	77.3	9.0	8.0	0.6	89.1	89.1	90.0	8.1	83.8	13.5	13.0	0.9
D20	86.9	79.2	7.7	6.9	0.4	89.6	91.0	91.9	7.1	84.1	13.0	12.0	1.4
D21	84.8	77.7	7.1	6.9	0.5	87.8	90.2	91.1	6.7	83.1	10.5	10.0	0.9
D22	86.3	78.6	7.7	6.8	0.4	89.1	90.8	91.7	6.8	83.3	13.5	12.0	1.1
D23	86.7	80.5	6.2	6.8	0.5	89.9	93.1	93.9	6.7	87.7	8.0	8.0	0.7
Avg.	86.2	78.7	7.5	7.1	0.5	89.1	90.8	91.7	7.1	84.4	11.7	11.0	1.0
Std Dv	0.8	1.3	1.0	0.5	0.1	0.8	1.4	1.4	0.6	1.9	2.4	2.0	0.2
90% CI	0.8	1.2	1.0	0.5	0.1	0.8	1.4	1.3	0.6	1.8	2.3	1.9	0.2
1000 FT. FLYOVER -- TARGET IAS 145 KTS													
E24	84.1	75.1	8.9	7.4	0.5	86.5	86.7	87.3	7.6	94.7	16.0	16.5	0.6
E25	83.9	74.0	9.9	7.6	0.5	86.1	84.6	85.7	7.9	93.0	20.0	20.5	1.1
E26	83.5	74.4	9.2	7.6	0.5	86.0	85.5	86.3	7.6	94.5	16.0	18.5	1.1
E27	85.3	76.8	8.5	7.1	0.5	87.6	88.5	89.0	7.3	95.1	15.5	14.5	0.8
E28	84.0	75.0	9.0	7.4	0.5	86.6	86.7	87.6	7.4	94.7	16.5	16.0	1.4
Avg.	84.2	75.1	9.1	7.4	0.5	86.5	86.4	87.2	7.6	94.4	16.8	17.2	1.0
Std Dv	0.7	1.1	0.5	0.2	0.0	0.6	1.4	1.3	0.2	0.8	1.8	2.3	0.3
90% CI	0.7	1.0	0.5	0.2	0.0	0.6	1.4	1.2	0.2	0.8	1.7	2.2	0.3

TABLE NO. A.4-1G

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/10/84

SITE: 1G CENTERLINE-CENTER (FLUSH) JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC

---------- NO DATA ----------

TABLE NO. A.4-2.1

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/10/84

SITE: 2 SIDELINE - 150 M. SOUTH JUNE 13,1983

TAKEOFF -- Target IAS 74 KTS (ICAO)

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
F29	89.3	81.8	7.5	6.9	0.5	91.4	91.9	93.5	6.9	85.7	12.5	14.0	1.6
F30	89.5	81.8	7.7	6.8	0.4	91.7	92.0	93.4	7.1	85.9	13.5	14.5	1.5
F31	89.6	81.2	8.4	7.3	0.5	92.0	91.7	93.4	7.3	85.6	14.0	15.0	1.7
F32	89.0	80.9	8.1	6.8	0.4	91.1	91.0	92.4	6.9	85.2	16.0	18.0	1.3
F33	89.3	82.0	7.4	6.7	0.4	91.5	92.0	93.4	7.0	85.9	12.5	15.0	1.5
F34	88.6	79.9	8.7	7.2	0.5	90.9	90.3	91.6	7.6	85.3	16.0	16.5	1.4
F35	88.9	81.2	7.7	6.8	0.4	91.6	91.5	93.2	7.3	86.5	13.5	14.0	2.0
F36	88.2	79.3	8.8	7.5	0.5	-	90.0	91.2	-	85.5	15.0	-	1.3
Avg.	89.1	81.0	8.0	7.0	0.5	91.5	91.3	92.8	7.2	85.7	14.1	15.3	1.5
Std Dv	0.5	0.9	0.5	0.3	0.0	0.4	0.8	0.9	0.3	0.4	1.4	1.5	0.2
90% CI	0.3	0.6	0.4	0.2	0.0	0.3	0.5	0.6	0.2	0.3	0.9	1.1	0.2

TAKEOFF -- CATERGORY B (SEE TEXT)

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
H44	90.5	82.8	7.7	6.9	0.5	92.5	92.7	93.7	7.6	87.1	13.0	14.0	1.3
H45	89.7	81.3	8.5	7.3	0.5	91.8	91.6	93.1	7.5	85.5	14.5	15.0	1.6
H46	90.0	82.1	8.0	7.2	0.5	92.2	92.0	93.2	7.7	86.6	13.0	14.5	1.6
H47	89.4	80.4	9.1	7.5	0.5	91.8	91.2	93.4	7.0	84.2	16.0	16.0	2.2
H48	90.5	82.3	8.2	7.2	0.5	92.7	93.3	95.2	6.8	86.5	13.5	13.0	1.9
H49	89.4	80.6	8.7	7.1	0.4	91.9	91.4	93.1	7.2	84.7	17.0	17.0	1.7
Avg.	89.9	81.6	8.4	7.2	0.5	92.2	92.0	93.6	7.3	85.8	14.5	14.9	1.7
Std Dv	0.5	1.0	0.5	0.2	0.0	0.4	0.8	0.8	0.4	1.2	1.7	1.4	0.3
90% CI	0.4	0.8	0.4	0.2	0.0	0.3	0.7	0.7	0.3	0.9	1.4	1.2	0.2

TAKEOFF (WITH TURN) -- TARGET IAS 74 KTS

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
J56	86.2	77.1	9.1	7.7	0.5	89.1	88.6	90.1	7.7	83.1	15.0	14.5	2.1
J57	86.4	77.3	9.1	7.7	0.5	89.2	88.2	90.1	7.8	83.2	15.0	15.0	1.8
J58	87.0	78.4	8.5	7.3	0.5	89.7	89.3	91.1	7.3	83.5	14.5	14.5	2.0
J59	87.3	78.5	8.8	7.6	0.5	90.1	89.6	91.6	7.4	83.2	14.5	14.0	2.1
J60	88.1	79.7	8.4	7.5	0.5	90.9	90.8	92.2	7.8	86.9	13.0	13.0	1.7
Avg.	87.0	78.2	8.8	7.6	0.5	89.8	89.3	91.0	7.6	84.0	14.4	14.2	1.9
Std Dv	0.8	1.1	0.3	0.2	0.0	0.7	1.0	0.9	0.2	1.6	0.8	0.8	0.2
90% CI	0.7	1.0	0.3	0.1	0.0	0.7	0.9	0.9	0.2	1.5	0.8	0.7	0.2

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.4-2.2

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/ 9/84

SITE: 2 SIDELINE - 150 M. SOUTH JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
3 DEGREE APPROACH -- TARGET IAS 74 KTS													
G37	87.6	79.8	7.8	7.2	0.5	91.3	92.4	94.2	7.0	86.9	12.0	10.5	1.8
G38	89.0	80.8	8.2	6.9	0.4	92.4	92.9	94.6	7.1	87.2	15.0	12.5	1.7
G39	87.0	78.5	8.5	7.6	0.5	90.2	90.7	92.3	7.4	86.3	13.0	12.0	1.6
G40	87.3	78.9	8.4	7.2	0.5	90.8	91.5	93.6	6.3	86.5	14.5	13.5	2.1
G41	85.0	79.2	5.7	5.7	0.4	87.9	90.7	91.9	6.4	85.7	10.0	9.0	1.2
G42	88.2	79.8	8.4	7.1	0.5	91.7	92.8	94.0	6.6	88.6	15.0	14.5	1.2
G43	87.4	78.0	9.4	7.6	0.5	90.6	89.9	92.5	6.8	85.8	17.0	15.0	2.6
Avg.	87.3	79.3	8.1	7.1	0.5	90.7	91.5	93.3	6.8	86.7	13.8	12.4	1.8
Std Dv	1.2	1.0	1.1	0.6	0.1	1.4	1.2	1.1	0.4	1.0	2.3	2.1	0.5
90% CI	0.9	0.7	0.8	0.5	0.0	1.0	0.9	0.8	0.3	0.7	1.7	1.6	0.4
6 DEGREE APPROACH -- TARGET IAS 74 KTS													
I50	90.3	81.4	8.9	7.3	0.5	93.4	92.6	94.1	7.6	89.0	16.5	16.5	1.6
I51	91.0	84.0	7.0	6.7	0.5	94.6	96.1	97.6	6.8	91.4	11.0	10.5	1.6
I52	----------			NO DATA		----------							
I53	91.6	83.4	8.3	6.5	0.4	94.6	95.5	97.4	6.1	90.6	18.5	15.0	1.9
I54	91.2	82.6	8.6	7.0	0.4	94.3	94.7	96.5	6.6	89.9	16.5	15.0	1.7
I55	90.8	81.8	9.0	7.6	0.5	94.0	94.2	95.3	7.5	89.3	15.0	14.5	1.1
Avg.	91.0	82.7	8.3	7.0	0.5	94.2	94.6	96.2	6.9	90.0	15.5	14.3	1.6
Std Dv	0.5	1.1	0.8	0.4	0.1	0.5	1.3	1.5	0.6	1.0	2.8	2.3	0.3
90% CI	0.5	1.0	0.8	0.4	0.1	0.5	1.3	1.4	0.6	0.9	2.7	2.1	0.3
9 DEGREE APPROACH -- TARGET IAS 74 KTS													
K61	87.1	78.7	8.3	7.4	0.5	90.6	91.1	92.6	7.2	88.1	13.5	13.0	1.6
K62	90.5	81.8	8.7	7.0	0.4	93.4	94.0	95.6	6.9	89.9	17.5	13.5	1.7
K63	87.7	78.3	9.3	6.8	0.4	90.9	90.7	92.2	6.7	86.8	23.0	20.5	1.4
K64	87.8	78.4	9.4	6.9	0.4	90.7	90.8	92.1	6.5	88.1	22.5	21.0	1.3
K65	89.1	82.6	6.5	5.6	0.3	92.2	94.8	95.8	6.2	90.1	15.0	11.0	0.9
K66	87.9	79.2	8.8	6.5	0.3	91.1	92.1	93.1	7.2	87.2	22.5	13.5	1.0
Avg.	88.3	79.8	8.5	6.7	0.4	91.5	92.3	93.6	6.8	88.4	19.0	15.4	1.3
Std Dv	1.2	1.9	1.0	0.6	0.1	1.1	1.7	1.7	0.4	1.4	4.2	4.2	0.3
90% CI	1.0	1.5	0.9	0.5	0.1	0.9	1.4	1.4	0.3	1.1	3.5	3.5	0.2

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.4-2.3

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/ 9/84

SITE: 2 SIDELINE - 150 M. SOUTH JUNE 13,1983

500 FT. FLYOVER -- TARGET IAS 145 KTS

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
A1	89.6	83.5	6.1	6.8	0.5	93.2	95.3	96.2	6.9	100.6	8.0	10.0	1.2
A2	90.6	83.3	7.3	7.3	0.5	93.0	95.0	95.8	7.2	96.9	10.0	10.0	0.7
A3	89.5	83.4	6.0	6.7	0.5	93.0	95.5	96.4	7.0	100.8	8.0	9.0	1.2
A5	89.3	83.1	6.1	6.6	0.5	-	94.4	95.7	-	100.1	8.5	-	1.4
A6	91.1	83.7	7.4	7.1	0.5	93.3	95.2	95.8	7.2	97.8	11.0	11.0	0.7
Avg.	90.0	83.4	6.6	6.9	0.5	93.1	95.1	96.0	7.1	99.2	9.1	10.0	1.1
Std Dv	0.8	0.2	0.7	0.3	0.0	0.1	0.4	0.3	0.1	1.8	1.3	0.8	0.3
90% CI	0.8	0.2	0.7	0.3	0.0	0.2	0.4	0.3	0.2	1.7	1.3	1.0	0.3

500 FT. FLYOVER -- TARGET IAS 130 KTS

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
B7	87.0	80.4	6.6	6.7	0.5	89.9	92.0	92.9	7.0	95.2	9.5	10.0	0.9
B8	89.0	80.8	8.1	7.5	0.5	90.9	91.8	92.7	7.6	91.7	12.0	12.0	0.9
B9	86.2	79.3	6.8	6.8	0.5	88.8	91.1	92.0	6.7	95.1	10.0	10.0	1.0
B10	88.3	80.1	8.2	7.4	0.5	90.5	91.5	92.5	7.2	91.5	13.0	12.5	1.1
B11	87.3	80.8	6.5	6.7	0.5	89.7	92.0	92.9	7.0	96.3	9.5	9.5	1.2
B12	88.7	80.7	7.9	7.5	0.5	90.8	92.0	93.0	7.4	92.9	11.5	11.5	0.9
B13	86.0	79.1	6.9	6.9	0.5	88.8	91.1	92.1	6.9	95.3	10.0	9.5	1.0
Avg.	87.5	80.2	7.3	7.1	0.5	89.9	91.6	92.6	7.1	94.0	10.8	10.7	1.0
Std Dv	1.2	0.7	0.8	0.4	0.0	0.9	0.4	0.4	0.3	1.9	1.4	1.3	0.1
90% CI	0.9	0.5	0.6	0.3	0.0	0.6	0.3	0.3	0.2	1.4	1.0	0.9	0.1

500 FT. FLYOVER -- TARGET IAS 115 KTS

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
C14	86.9	78.2	8.7	7.2	0.5	88.8	89.6	90.7	7.0	86.4	16.0	14.5	1.2
C15	85.5	78.6	6.9	6.9	0.5	87.9	90.1	90.9	7.1	90.4	10.0	9.5	0.9
C17	85.2	78.8	6.4	6.6	0.5	88.0	90.1	91.3	6.8	92.1	9.5	9.5	1.2
C18	86.9	78.4	8.4	7.4	0.5	88.9	89.8	90.6	7.2	86.9	14.0	14.0	0.8
Avg.	86.1	78.5	7.6	7.0	0.5	88.4	89.9	90.9	7.0	89.0	12.4	11.9	1.0
Std Dv	0.9	0.3	1.1	0.3	0.0	0.6	0.2	0.3	0.2	2.8	3.1	2.7	0.2
90% CI	1.0	0.3	1.3	0.4	0.0	0.7	0.2	0.4	0.2	3.3	3.7	3.2	0.3

500 FT. FLYOVER -- TARGET IAS 100 KTS

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
D19	84.7	76.1	8.6	7.5	0.5	87.0	86.9	88.3	7.7	85.2	14.0	13.5	1.4
D20	86.3	77.3	9.0	7.3	0.5	87.9	87.7	88.8	7.5	83.6	17.5	17.0	1.1
D21	84.1	76.7	7.4	7.0	0.5	86.3	87.6	88.7	7.1	84.9	11.5	12.0	1.1
D22	86.5	78.0	8.5	7.3	0.5	88.2	88.6	89.5	7.3	84.0	14.5	15.0	1.0
D23	85.3	78.2	7.1	7.1	0.5	87.9	89.6	90.9	7.0	86.6	10.0	10.0	1.6
Avg.	85.4	77.2	8.1	7.2	0.5	87.5	88.1	89.2	7.3	84.9	13.5	13.5	1.2
Std Dv	1.0	0.9	0.8	0.2	0.0	0.8	1.1	1.0	0.3	1.2	2.9	2.7	0.3
90% CI	1.0	0.8	0.8	0.2	0.0	0.8	1.0	1.0	0.3	1.1	2.8	2.6	0.3

1000 FT. FLYOVER -- TARGET IAS 145 KTS

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
E24	84.8	75.9	8.9	7.5	0.5	87.9	89.3	89.8	7.0	95.8	15.0	14.0	0.5
E25	85.2	75.2	9.9	8.0	0.6	-	86.0	87.2	-	92.4	17.5	-	1.8
E26	83.6	74.8	8.8	7.4	0.5	86.4	86.1	86.9	7.6	96.1	15.5	17.5	0.8
E27	86.8	77.7	9.0	7.6	0.5	89.4	89.7	90.5	7.5	96.5	15.5	15.5	1.2
E28	84.1	75.2	8.9	7.4	0.5	-	86.7	87.7	-	96.4	15.5	-	1.0
Avg.	84.9	75.8	9.1	7.6	0.5	87.9	87.6	88.4	7.4	95.4	15.8	15.7	1.1
Std Dv	1.2	1.2	0.5	0.2	0.0	1.5	1.8	1.6	0.3	1.7	1.0	1.8	0.5
90% CI	1.2	1.1	0.4	0.2	0.0	2.6	1.7	1.6	0.5	1.6	0.9	3.0	0.5

TABLE NO. A.4-3.1

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/5/84

SITE: 3 SIDELINE - 150 M. NORTH JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
TAKEOFF -- Target IAS 74 KTS (ICAO)													
F29	87.6	78.9	8.6	7.4	0.5	89.1	88.8	90.1	7.6	83.2	14.5	15.5	1.3
F30	88.2	80.2	8.1	7.1	0.5	90.0	89.9	91.0	7.6	84.1	13.5	15.0	1.1
F31	88.5	80.8	7.6	7.0	0.5	90.1	90.4	91.7	7.5	84.9	12.5	13.0	1.3
F32	87.6	79.2	8.3	7.4	0.5	89.2	89.1	90.2	7.7	83.4	13.5	14.5	1.1
F33	87.9	79.8	8.1	7.4	0.5	89.9	90.1	91.4	7.6	83.9	12.5	13.0	1.3
F34	86.9	78.2	8.7	7.5	0.5	88.8	88.5	89.6	7.7	82.7	14.5	15.5	1.1
F35	87.0	79.1	7.9	7.2	0.5	89.4	89.5	92.0	6.7	83.5	12.5	12.5	2.5
F36	86.0	77.7	8.3	7.1	0.5	88.0	88.1	89.3	7.4	82.8	14.5	15.0	1.2
Avg.	87.4	79.2	8.2	7.3	0.5	89.3	89.3	90.6	7.5	83.5	13.5	14.2	1.4
Std Dv	0.8	1.0	0.4	0.2	0.0	0.7	0.8	1.0	0.3	0.7	0.9	1.2	0.5
90% CI	0.5	0.7	0.2	0.1	0.0	0.5	0.5	0.7	0.2	0.5	0.6	0.8	0.3
TAKEOFF -- CATERGORY B (SEE TEXT)													
H44	88.7	80.8	7.8	7.4	0.5	90.6	91.1	92.1	7.9	85.0	11.5	12.0	1.1
H45	88.6	80.4	8.2	7.0	0.5	90.7	91.0	92.2	7.3	85.1	14.5	14.5	1.2
H46	88.8	81.2	7.6	7.1	0.5	91.1	91.7	93.1	7.4	86.1	11.5	12.0	1.4
H47	87.9	79.3	8.5	7.1	0.4	90.3	90.0	91.4	7.5	83.7	16.0	15.5	1.5
H48	87.7	79.0	8.7	7.1	0.4	89.9	89.8	91.2	7.2	84.1	16.5	16.5	1.4
H49	87.7	79.8	7.9	7.1	0.5	-	90.4	91.8	-	84.4	13.0	-	1.4
Avg.	88.2	80.1	8.1	7.1	0.5	90.5	90.7	92.0	7.5	84.7	13.8	14.1	1.3
Std Dv	0.5	0.9	0.4	0.1	0.0	0.4	0.7	0.7	0.3	0.9	2.2	2.0	0.2
90% CI	0.4	0.7	0.4	0.1	0.0	0.4	0.6	0.6	0.2	0.7	1.8	1.9	0.1
TAKEOFF (WITH TURN) -- TARGET IAS 74 KTS													
J56	90.9	82.6	8.3	7.2	0.5	93.3	93.4	95.2	7.1	86.5	14.0	14.0	1.8
J57	88.6	78.9	9.7	8.0	0.6	91.8	90.9	93.0	7.5	84.0	16.0	15.0	2.1
J58	89.5	80.7	8.8	7.4	0.5	91.9	92.1	93.6	6.9	85.0	15.5	16.0	1.5
J59	91.0	82.9	8.1	7.1	0.5	93.6	93.6	95.2	7.2	87.1	14.0	14.5	1.8
J60	89.7	79.9	9.8	7.6	0.5	92.5	91.5	92.6	7.1	83.7	19.5	24.5	1.1
Avg.	89.9	81.0	8.9	7.5	0.5	92.6	92.3	93.9	7.2	85.3	15.8	16.8	1.7
Std Dv	1.0	1.7	0.8	0.4	0.0	0.8	1.2	1.2	0.2	1.5	2.3	4.4	0.4
90% CI	1.0	1.6	0.7	0.3	0.0	0.8	1.1	1.2	0.2	1.4	2.1	4.2	0.4

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.4-3.2

SIKORSKY S-76 HELICOPTER (SPIRIT)

DOT/TSC
5/ 9/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 3 SIDELINE - 150 M. NORTH JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
3 DEGREE APPROACH -- TARGET IAS 74 KTS													
G37	86.9	77.9	8.9	7.7	0.5	90.2	90.1	91.9	7.4	86.1	14.5	13.0	2.0
G38	87.0	76.7	10.3	8.2	0.6	90.3	89.3	91.1	7.7	86.5	18.0	16.0	2.0
G39	86.0	77.3	8.7	7.6	0.5	89.2	89.2	90.7	7.6	85.6	14.0	13.0	1.7
G40	86.7	76.9	9.8	7.8	0.5	89.3	88.8	90.5	7.5	85.4	18.0	14.5	1.7
G41	86.7	77.0	9.8	7.2	0.4	89.1	88.9	90.2	7.1	86.3	23.0	18.0	1.4
G42	88.3	79.0	9.2	7.4	0.5	90.9	90.3	91.6	7.5	85.7	18.0	17.0	1.7
G43	87.7	77.6	10.1	7.9	0.5	90.0	88.5	90.6	7.5	84.1	19.0	18.0	2.2
Avg.	87.0	77.5	9.5	7.7	0.5	89.9	89.3	91.0	7.5	85.7	17.8	15.6	1.8
Std Dv	0.7	0.8	0.6	0.3	0.1	0.7	0.7	0.6	0.2	0.8	3.0	2.2	0.3
90% CI	0.5	0.6	0.4	0.2	0.0	0.5	0.5	0.4	0.1	0.6	2.2	1.6	0.2
6 DEGREE APPROACH -- TARGET IAS 74 KTS													
I50		----------		NO DATA		----------							
I51		----------		NO DATA		----------							
I52		----------		NO DATA		----------							
I53	83.8	77.1	6.7	7.1	0.5	87.6	89.9	91.2	6.8	85.7	9.0	8.5	1.3
I54	87.0	77.2	9.7	7.8	0.5	90.7	90.6	91.9	7.5	86.2	17.5	15.0	1.3
I55	85.6	76.8	8.8	7.3	0.5	89.7	89.1	90.9	7.6	85.4	16.5	14.5	1.8
Avg.	85.5	77.0	8.4	7.4	0.5	89.3	89.9	91.4	7.3	85.8	14.3	12.7	1.5
Std Dv	1.6	0.2	1.5	0.4	0.0	1.6	0.7	0.5	0.4	0.4	4.6	3.6	0.3
90% CI	2.7	0.4	2.6	0.7	0.1	2.7	1.2	0.8	0.7	0.6	7.8	6.1	0.5
9 DEGREE APPROACH -- TARGET IAS 74 KTS													
K61	82.7	73.6	9.1	7.8	0.6	86.6	85.1	88.7	7.0	83.5	14.5	13.0	3.6
K62	84.6	74.0	10.5	8.2	0.6	88.2	87.1	89.4	7.3	82.7	19.0	16.0	3.3
K63	85.0	75.5	9.5	6.8	0.4	87.8	85.7	87.9	7.1	81.0	24.5	24.5	2.2
K64	83.4	73.5	9.9	7.3	0.4	86.7	85.1	86.8	7.4	82.0	22.5	21.5	2.5
K65	84.7	75.8	8.9	6.5	0.3	87.9	88.8	89.9	6.4	84.0	23.5	18.0	1.1
K66	83.5	74.5	9.0	6.2	0.3	86.0	86.9	87.6	7.1	81.4	29.0	15.5	0.9
Avg.	84.0	74.5	9.5	7.1	0.4	87.2	86.4	88.4	7.1	82.4	22.2	18.1	2.3
Std Dv	0.9	1.0	0.6	0.8	0.1	0.9	1.4	1.2	0.4	1.2	5.0	4.2	1.1
90% CI	0.8	0.8	0.5	0.7	0.1	0.7	1.2	1.0	0.3	1.0	4.1	3.5	0.9

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.4-3.3

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/5/84

SITE: 3 SIDELINE - 150 M. NORTH JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 145 KTS													
A1	90.2	82.5	7.7	7.4	0.5	91.7	93.5	94.2	7.5	96.3	11.0	10.0	0.9
A2	89.0	82.5	6.5	6.8	0.5	-	93.5	94.9	-	98.2	9.0	-	1.6
A3	90.3	82.8	7.5	7.5	0.6	92.1	93.6	94.3	7.8	97.4	10.0	10.0	1.0
A5	90.4	82.9	7.5	7.5	0.6	-	93.4	94.1	-	96.6	10.0	-	0.7
A6	89.7	83.6	6.1	6.5	0.5	93.0	94.6	96.1	7.1	99.8	8.5	9.5	1.4
Avg.	89.9	82.9	7.1	7.2	0.5	92.3	93.7	94.7	7.5	97.7	9.7	9.8	1.1
Std Dv	0.6	0.4	0.7	0.4	0.0	0.7	0.5	0.8	0.4	1.4	1.0	0.3	0.4
90% CI	0.5	0.4	0.7	0.4	0.0	1.1	0.5	0.8	0.6	1.3	0.9	0.5	0.4
500 FT. FLYOVER -- TARGET IAS 130 KTS													
B7	87.7	79.8	7.8	7.3	0.5	88.9	90.3	91.1	7.4	89.8	12.0	11.0	0.9
B8	87.3	80.7	6.5	6.7	0.5	89.3	91.2	92.6	6.8	95.2	9.5	9.5	1.6
B9	87.8	79.5	8.3	7.7	0.6	89.1	90.1	90.9	7.6	90.4	12.0	12.0	0.7
B10	86.9	80.0	6.8	6.8	0.5	89.2	90.9	92.3	6.6	94.7	10.0	11.0	1.6
B11	88.6	80.9	7.8	7.5	0.5	90.1	91.6	92.3	7.3	92.3	11.0	11.5	0.7
B12	87.4	80.8	6.6	7.0	0.5	89.9	91.8	93.3	6.7	95.7	9.0	9.5	1.5
B13	87.0	78.9	8.2	7.6	0.5	88.6	89.6	90.3	7.5	91.1	12.0	12.5	0.9
Avg.	87.5	80.1	7.4	7.2	0.5	89.3	90.8	91.8	7.2	92.7	10.8	11.0	1.1
Std Dv	0.6	0.7	0.7	0.4	0.0	0.5	0.8	1.1	0.4	2.4	1.3	1.2	0.4
90% CI	0.4	0.5	0.5	0.3	0.0	0.4	0.6	0.8	0.3	1.8	0.9	0.8	0.3
500 FT. FLYOVER -- TARGET IAS 115 KTS													
C14	85.9	78.1	7.8	7.2	0.5	87.7	88.5	89.9	7.2	89.0	12.0	12.5	1.5
C15	86.3	78.7	7.7	7.1	0.5	87.4	89.1	89.8	7.1	85.9	12.0	11.5	0.7
C17	85.6	78.5	7.0	6.9	0.5	87.0	89.1	90.0	7.1	87.0	10.5	10.0	0.8
C18	85.6	78.1	7.5	7.1	0.5	87.3	88.4	89.6	7.4	89.0	11.5	11.0	1.5
Avg.	85.9	78.4	7.5	7.1	0.5	87.4	88.8	89.8	7.2	87.7	11.5	11.2	1.1
Std Dv	0.4	0.3	0.3	0.1	0.0	0.3	0.4	0.2	0.2	1.5	0.7	1.0	0.4
90% CI	0.4	0.3	0.4	0.1	0.0	0.3	0.4	0.2	0.2	1.8	0.8	1.2	0.5
500 FT. FLYOVER -- TARGET IAS 100 KTS													
D19	87.0	79.2	7.8	6.9	0.4	88.1	89.2	90.4	7.0	83.7	13.5	12.5	1.1
D20	85.3	77.5	7.9	7.3	0.5	87.3	87.9	89.3	7.3	85.0	12.0	12.5	1.4
D21	85.1	77.5	7.6	7.2	0.5	86.5	88.0	88.9	7.2	83.9	11.5	11.5	0.8
D22	85.5	77.6	7.9	7.2	0.5	87.3	88.0	89.1	7.3	84.0	12.5	13.0	1.2
D23	86.2	78.4	7.8	6.4	0.4	87.6	89.1	89.9	6.5	85.2	16.0	15.0	0.8
Avg.	85.8	78.0	7.8	7.0	0.5	87.4	88.4	89.5	7.1	84.4	13.1	12.9	1.1
Std Dv	0.8	0.7	0.1	0.3	0.1	0.6	0.7	0.6	0.3	0.7	1.8	1.3	0.3
90% CI	0.7	0.7	0.1	0.3	0.1	0.5	0.6	0.6	0.3	0.6	1.7	1.2	0.3
1000 FT. FLYOVER -- TARGET IAS 145 KTS													
E24	85.0	75.4	9.6	7.9	0.5	87.2	86.7	87.8	7.8	93.4	16.5	16.0	1.4
E25	84.4	76.2	8.1	6.4	0.4	-	86.4	87.4	-	94.4	18.5	-	1.0
E26	85.5	75.9	9.6	8.1	0.6	87.8	87.7	88.8	7.8	94.1	15.5	14.5	1.3
E27	85.6	78.2	7.5	6.6	0.4	88.3	88.9	89.8	7.0	95.9	13.5	16.0	1.0
E28	85.9	76.4	9.4	7.7	0.5	88.2	87.9	89.3	7.4	94.3	16.5	16.0	1.4
Avg.	85.3	76.4	8.8	7.3	0.5	87.9	87.5	88.6	7.5	94.4	16.1	15.6	1.2
Std Dv	0.6	1.0	1.0	0.8	0.1	0.5	1.0	1.0	0.4	0.9	1.8	0.7	0.2
90% CI	0.6	1.0	0.9	0.7	0.1	0.6	0.9	1.0	0.4	0.9	1.7	0.9	0.2

TABLE NO. A.4-4.1

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/10/84

SITE: 4 CENTERLINE - 150 M. WEST JUNE 13,1983

TAKEOFF -- Target IAS 74 KTS (ICAO)

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
F29	84.4	76.3	8.1	7.3	0.5	87.9	88.6	89.9	7.2	79.7	13.0	12.5	1.3
F30	86.7	78.5	8.2	7.6	0.6	90.1	90.2	91.8	7.7	81.1	12.0	12.0	2.1
F31	86.6	77.7	8.9	7.8	0.6	89.6	89.7	91.7	7.1	80.3	14.0	13.0	2.0
F32	85.5	77.2	8.3	7.3	0.5	88.9	88.8	90.9	7.3	80.0	13.5	12.5	2.1
F33	85.8	78.4	7.4	7.1	0.5	89.4	90.0	92.2	7.0	80.7	11.0	10.5	2.2
F34	85.0	77.6	7.4	6.8	0.4	88.6	89.3	91.3	6.8	79.3	12.5	12.0	2.1
F35	85.7	78.5	7.3	7.4	0.6	89.6	90.3	92.5	7.4	82.0	9.5	9.0	2.2
F36	85.2	76.7	8.6	7.6	0.5	88.5	88.6	90.5	7.4	80.7	13.5	12.0	2.0
Avg.	85.6	77.6	8.0	7.4	0.5	89.1	89.4	91.4	7.2	80.5	12.4	11.7	2.0
Std Dv	0.8	0.8	0.6	0.3	0.0	0.7	0.7	0.9	0.3	0.9	1.5	1.3	0.3
90% CI	0.5	0.6	0.4	0.2	0.0	0.5	0.5	0.6	0.2	0.6	1.0	0.9	0.2

TAKEOFF -- CATERGORY B (SEE TEXT)

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
H44	87.4	80.2	7.2	7.2	0.5	90.7	92.0	93.8	6.9	82.3	10.0	10.0	1.9
H45	87.7	80.5	7.2	6.8	0.5	90.8	92.4	93.4	7.3	83.3	11.5	10.5	0.9
H46	88.2	80.6	7.6	7.3	0.5	91.5	92.5	94.1	7.2	83.3	11.0	10.5	1.6
H47	87.0	79.4	7.6	6.7	0.4	90.3	91.6	92.5	7.0	81.7	13.5	13.0	0.9
H48	85.6	76.6	8.9	7.6	0.5	88.8	88.7	90.0	7.7	80.3	15.0	14.0	1.9
H49	87.2	79.7	7.5	7.0	0.5	90.6	91.8	93.1	7.1	82.0	12.0	11.5	1.6
Avg.	87.2	79.5	7.7	7.1	0.5	90.4	91.5	92.8	7.2	82.1	12.2	11.6	1.5
Std Dv	0.9	1.5	0.7	0.3	0.0	0.9	1.4	1.5	0.3	1.1	1.8	1.6	0.5
90% CI	0.7	1.2	0.5	0.3	0.0	0.8	1.2	1.2	0.2	0.9	1.5	1.3	0.4

TAKEOFF (WITH TURN) -- TARGET IAS 74 KTS

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
J56	84.1	76.9	7.2	7.5	0.6	-	88.2	89.7	-	80.6	9.0	-	1.6
J57	83.6	75.1	8.5	7.3	0.5	86.7	87.0	88.8	7.3	78.8	14.5	12.0	1.7
J58	84.4	77.0	7.5	6.7	0.4	87.5	88.8	90.8	6.4	80.3	13.0	11.5	2.0
J59	85.4	78.1	7.3	6.9	0.5	88.4	89.2	90.8	7.1	80.7	11.5	11.5	1.6
J60	86.1	78.9	7.2	6.8	0.5	89.7	91.1	92.8	6.7	81.0	11.5	10.5	1.7
Avg.	84.7	77.2	7.5	7.1	0.5	88.1	88.9	90.6	6.9	80.3	11.9	11.4	1.7
Std Dv	1.0	1.4	0.6	0.4	0.1	1.3	1.5	1.5	0.4	0.9	2.0	0.6	0.2
90% CI	1.0	1.4	0.5	0.3	0.1	1.5	1.4	1.4	0.5	0.8	1.9	0.7	0.2

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.4-4.2

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/5/84

SITE: 4 CENTERLINE - 150 M. WEST JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
3 DEGREE APPROACH -- TARGET IAS 74 KTS													
G37	90.9	84.8	6.2	6.6	0.5	94.5	98.1	98.9	6.4	94.5	8.5	7.5	0.9
G38	93.6	86.0	7.6	7.5	0.6	96.5	98.8	99.7	6.8	94.6	10.5	10.0	0.9
G39	87.3	79.5	7.8	8.4	0.7	-	92.4	93.6	-	88.2	8.5	-	1.2
G40	90.5	83.5	7.0	6.9	0.5	93.7	95.9	96.7	6.9	90.6	10.5	10.0	0.8
G41	93.6	86.5	7.2	7.3	0.5	96.5	98.9	99.7	6.8	95.7	9.5	10.0	0.8
G42	90.7	83.5	7.2	6.7	0.4	93.8	95.3	96.0	7.1	90.6	12.0	12.5	0.8
G43	91.3	85.1	6.2	6.3	0.4	93.9	96.5	97.2	6.8	91.5	9.5	9.5	0.7
Avg.	91.1	84.1	7.0	7.1	0.5	94.8	96.5	97.4	6.8	92.2	9.9	9.9	0.9
Std Dv	2.1	2.3	0.6	0.7	0.1	1.3	2.3	2.2	0.2	2.7	1.2	1.6	0.2
90% CI	1.6	1.7	0.5	0.5	0.1	1.1	1.7	1.6	0.2	2.0	0.9	1.3	0.1
6 DEGREE APPROACH -- TARGET IAS 74 KTS													
I50	92.7	88.0	4.7	5.1	0.3	95.7	99.9	100.4	5.6	96.0	8.5	9.0	0.5
I51	92.1	85.2	6.9	6.2	0.4	95.2	97.6	98.3	6.2	94.1	13.0	13.0	0.8
I52	91.9	84.7	7.2	6.6	0.4	-	96.9	97.9	-	91.9	12.0	-	1.0
I53	92.7	83.3	9.4	7.5	0.5	95.5	96.2	96.8	7.4	91.9	18.0	14.5	0.6
I54	93.3	86.1	7.2	6.8	0.5	96.5	98.9	99.6	6.7	95.3	11.5	11.0	0.7
I55	92.8	87.8	4.9	5.5	0.4	95.9	99.6	100.2	6.1	95.5	8.0	8.5	0.6
Avg.	92.6	85.9	6.7	6.3	0.4	95.8	98.2	98.9	6.4	94.1	11.8	11.2	0.7
Std Dv	0.5	1.8	1.7	0.9	0.1	0.5	1.5	1.4	0.7	1.8	3.6	2.6	0.2
90% CI	0.4	1.5	1.4	0.7	0.0	0.5	1.2	1.2	0.7	1.5	3.0	2.4	0.1
9 DEGREE APPROACH -- TARGET IAS 74 KTS													
K61	84.5	76.2	8.2	7.3	0.5	-	88.4	89.1	-	88.1	13.5	-	0.7
K62	90.7	83.2	7.5	6.5	0.4	93.7	95.3	96.0	6.9	91.0	14.0	13.0	0.9
K63	86.9	76.8	10.1	7.8	0.5	90.1	89.9	90.6	7.4	86.3	20.0	19.0	0.7
K64	86.9	78.0	8.9	6.3	0.3	89.6	91.5	92.2	6.5	88.8	26.0	14.0	0.7
K65	88.0	80.4	7.6	5.6	0.3	91.0	93.2	94.0	6.1	90.1	23.0	13.5	0.9
K66	86.7	77.7	9.0	6.7	0.4	90.2	91.0	91.8	6.7	87.4	22.0	18.0	0.8
Avg.	87.3	78.7	8.5	6.7	0.4	90.9	91.5	92.3	6.7	88.6	19.7	15.5	0.8
Std Dv	2.0	2.6	1.0	0.8	0.1	1.6	2.4	2.5	0.5	1.7	5.0	2.8	0.1
90% CI	1.7	2.2	0.8	0.6	0.1	1.6	2.0	2.0	0.4	1.4	4.1	2.7	0.1

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.4-4.3

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/ 9/84

SITE: 4 CENTERLINE - 150 M. WEST JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 145 KTS													
A1	90.2	85.0	5.2	5.9	0.4	93.4	97.4	98.0	6.1	99.3	7.5	7.5	0.6
A2	90.0	84.1	5.9	6.3	0.5	92.7	96.4	96.6	6.7	98.2	8.5	8.0	0.3
A3	89.9	84.6	5.3	6.3	0.5	93.0	97.1	97.6	6.2	99.1	7.0	7.5	0.5
A5	90.0	84.4	5.6	6.2	0.5	93.3	97.1	97.8	6.1	99.1	8.0	8.0	0.7
A6	90.3	84.2	6.0	6.5	0.5	93.3	96.8	97.4	6.5	98.1	8.5	8.0	0.6
Avg.	90.1	84.5	5.6	6.2	0.5	93.1	97.0	97.5	6.3	98.8	7.9	7.8	0.5
Std Dv	0.2	0.4	0.4	0.2	0.0	0.3	0.4	0.5	0.3	0.6	0.7	0.3	0.2
90% CI	0.2	0.3	0.3	0.2	0.0	0.3	0.4	0.5	0.2	0.5	0.6	0.3	0.1
500 FT. FLYOVER -- TARGET IAS 130 KTS													
B7	87.8	82.1	5.7	6.5	0.5	91.1	94.8	95.5	6.4	93.0	7.5	7.5	0.7
B8	88.1	82.2	5.9	6.4	0.5	91.1	94.2	95.2	6.5	93.2	8.5	8.0	1.0
B9	86.9	80.7	6.1	6.6	0.5	89.8	92.9	94.0	6.2	92.4	8.5	8.5	1.2
B10				NO DATA									
B11	87.5	81.7	5.9	6.3	0.5	90.4	94.0	94.6	6.4	92.8	8.5	8.0	0.6
B12	88.3	82.4	5.9	6.5	0.5	91.2	94.5	95.4	6.2	93.3	8.0	8.5	0.9
B13	86.0	79.8	6.2	6.5	0.5	88.7	91.9	92.6	6.4	91.8	9.0	9.0	0.7
Avg.	87.4	81.5	5.9	6.5	0.5	90.4	93.7	94.6	6.4	92.8	8.3	8.2	0.8
Std Dv	0.9	1.0	0.2	0.1	0.0	1.0	1.1	1.1	0.1	0.6	0.5	0.5	0.2
90% CI	0.7	0.8	0.1	0.1	0.0	0.8	0.9	0.9	0.1	0.5	0.4	0.4	0.2
500 FT. FLYOVER -- TARGET IAS 115 KTS													
C14	85.6	78.4	7.2	6.8	0.5	88.2	90.1	91.1	6.9	85.5	11.5	11.0	1.0
C15	86.2	80.4	5.8	6.4	0.5	89.3	92.5	93.5	6.2	86.3	8.0	8.5	0.9
C17	83.6	77.7	5.8	6.3	0.5	86.1	89.1	90.0	6.3	88.1	8.5	9.0	1.0
C18	86.2	79.7	6.6	6.6	0.5	89.0	91.6	92.6	6.6	86.4	10.0	9.5	0.9
Avg.	85.4	79.1	6.4	6.5	0.5	88.1	90.8	91.8	6.5	86.6	9.5	9.5	1.0
Std Dv	1.3	1.2	0.7	0.2	0.0	1.5	1.6	1.5	0.3	1.1	1.6	1.1	0.0
90% CI	1.5	1.4	0.8	0.3	0.0	1.7	1.8	1.8	0.4	1.3	1.9	1.3	0.0
500 FT. FLYOVER -- TARGET IAS 100 KTS													
D19	86.6	79.9	6.7	6.7	0.5	89.4	92.0	92.6	6.8	85.6	10.0	10.0	0.6
D20	86.1	78.2	7.9	7.1	0.5	88.9	90.1	91.3	6.9	81.5	13.0	12.5	1.3
D21	83.9	77.2	6.7	6.7	0.5	86.9	89.3	90.2	6.7	81.6	10.0	10.0	0.9
D22	85.8	77.8	7.9	7.2	0.5	88.8	90.4	91.6	6.9	82.0	12.5	11.0	1.2
D23	85.6	78.8	6.8	6.1	0.4	88.4	91.1	92.3	6.4	84.4	13.0	9.0	1.3
Avg.	85.6	78.4	7.2	6.8	0.5	88.5	90.6	91.6	6.7	83.0	11.7	10.5	1.1
Std Dv	1.0	1.0	0.6	0.4	0.1	1.0	1.0	0.9	0.2	1.9	1.6	1.3	0.3
90% CI	1.0	1.0	0.6	0.4	0.0	0.9	1.0	0.9	0.2	1.8	1.5	1.3	0.3
1000 FT. FLYOVER -- TARGET IAS 145 KTS													
E24	83.6	74.9	8.6	7.3	0.5	85.7	86.3	87.5	7.3	92.4	15.0	13.5	1.2
E25	83.3	74.6	8.8	7.0	0.4	-	85.6	86.5	-	90.6	17.5	-	0.8
E26	83.3	74.6	8.7	7.4	0.5	85.7	86.5	87.1	7.2	93.0	15.0	15.5	0.7
E27	85.5	77.7	7.8	6.8	0.4	88.0	88.8	89.3	7.3	94.6	14.0	15.5	1.0
E28	84.4	76.0	8.4	7.1	0.5	86.8	87.7	88.4	7.1	93.1	15.0	15.0	0.9
Avg.	84.0	75.6	8.5	7.1	0.5	86.6	87.0	87.8	7.2	92.7	15.3	14.9	0.9
Std Dv	0.9	1.3	0.4	0.2	0.0	1.1	1.3	1.1	0.1	1.5	1.3	0.9	0.2
90% CI	0.9	1.3	0.4	0.2	0.0	1.2	1.2	1.1	0.1	1.4	1.2	1.1	0.2

TABLE NO. A.4-5.1

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/7/84

SITE: 5 CENTERLINE - 188 M. EAST JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
TAKEOFF -- Target IAS 74 KTS (ICAO)													
F29	86.8	79.6	7.2	7.4	0.6	90.9	92.0	94.3	6.9	84.1	9.5	9.0	2.3
F30	87.1	79.3	7.7	7.4	0.5	90.9	92.0	94.3	6.8	84.1	11.0	9.5	2.4
F31	88.1	80.9	7.1	7.1	0.5	91.8	93.4	95.2	6.9	84.2	10.0	9.0	1.9
F32	85.9	79.0	6.9	6.8	0.5	90.0	91.2	93.1	6.8	81.9	10.5	10.5	2.0
F33	86.4	80.0	6.4	6.7	0.5	90.7	92.4	94.6	6.6	82.9	9.0	8.5	2.2
F34	87.7	81.3	6.4	6.9	0.5	91.8	93.8	95.9	6.7	84.2	8.5	7.5	2.1
F35	87.9	81.8	6.1	6.8	0.5	91.9	94.4	96.0	6.8	85.1	8.0	7.5	1.6
F36	87.4	81.1	6.3	6.7	0.5	91.7	93.9	96.0	6.3	84.7	8.5	8.0	2.1
Avg.	87.2	80.4	6.8	7.0	0.5	91.2	92.9	94.9	6.7	83.9	9.4	8.7	2.1
Std Dv	0.7	1.0	0.6	0.3	0.0	0.7	1.1	1.1	0.2	1.0	1.1	1.0	0.2
90% CI	0.5	0.7	0.4	0.2	0.0	0.5	0.8	0.7	0.1	0.7	0.7	0.7	0.2
TAKEOFF -- CATERGORY B (SEE TEXT)													
H44	88.6	81.3	7.3	7.1	0.5	92.4	93.7	95.9	6.6	83.7	10.5	10.0	2.1
H45	87.9	79.5	8.3	7.4	0.5	91.8	91.9	93.7	7.2	82.3	13.5	13.0	1.7
H46	88.1	79.9	8.3	7.5	0.5	92.1	92.5	94.6	7.2	83.2	12.5	11.0	2.3
H47	87.3	79.2	8.1	7.0	0.5	91.2	91.9	94.0	6.7	82.2	14.0	12.0	2.2
H48	88.0	80.3	7.7	7.1	0.5	92.0	92.9	95.1	6.6	83.5	12.0	11.0	2.2
H49	87.6	79.0	8.6	7.4	0.5	91.5	91.4	93.3	7.3	81.7	14.5	13.5	1.8
Avg.	87.9	79.9	8.0	7.3	0.5	91.8	92.4	94.4	6.9	82.8	12.8	11.7	2.1
Std Dv	0.4	0.8	0.5	0.2	0.0	0.4	0.8	1.0	0.3	0.8	1.5	1.3	0.2
90% CI	0.4	0.7	0.4	0.2	0.0	0.4	0.7	0.8	0.3	0.7	1.2	1.1	0.2
TAKEOFF (WITH TURN) -- TARGET IAS 74 KTS													
J56	89.0	82.7	6.2	6.7	0.5	93.2	95.5	97.1	6.9	85.8	8.5	7.5	2.1
J57	87.9	80.6	7.2	7.2	0.5	92.0	93.5	95.4	7.0	84.4	10.0	9.0	2.1
J58	88.3	82.1	6.1	6.6	0.5	92.2	94.9	96.5	6.6	85.7	8.5	7.5	1.6
J59	88.4	82.0	6.4	6.5	0.5	92.5	94.7	96.6	6.4	85.7	9.5	8.5	2.2
J60	88.9	83.0	5.9	6.7	0.5	93.1	95.7	97.9	6.2	86.4	7.5	7.0	2.3
Avg.	88.5	82.1	6.4	6.8	0.5	92.6	94.9	96.7	6.6	85.6	8.8	7.9	2.0
Std Dv	0.5	0.9	0.5	0.3	0.0	0.5	0.9	0.9	0.3	0.7	1.0	0.8	0.3
90% CI	0.4	0.9	0.5	0.3	0.0	0.5	0.8	0.9	0.3	0.7	0.9	0.8	0.3

* - NOISE INDEXES CALCULATED USING MEASURED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.4-5.2

SIKORSKY S-76 HELICOPTER (SPIRIT)

DOT/TSC
5/7/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 5 CENTERLINE - 188 M. EAST JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	DASPLm	DUR(A)	DUR(P)	TC
3 DEGREE APPROACH -- TARGET IAS 74 KTS													
G37	93.8	86.6	7.2	7.0	0.5	96.5	98.4	99.1	7.1	94.3	10.5	11.0	0.9
G38	94.6	89.8	4.8	5.5	0.4	97.2	101.9	102.3	5.6	98.4	7.5	7.5	0.5
G39	94.6	88.0	6.6	6.9	0.5	-	100.6	101.3	-	96.9	9.0	-	0.6
G40	93.1	86.3	6.8	6.8	0.5	96.1	98.2	98.9	7.0	93.1	10.0	10.5	0.7
G41	92.9	85.9	7.0	7.0	0.5	95.6	97.2	97.8	7.7	92.8	10.0	10.5	0.6
G42	94.1	86.9	7.2	7.2	0.5	96.9	98.7	99.3	7.5	95.7	10.0	10.0	0.6
G43	90.5	82.4	8.1	6.8	0.4	93.4	94.9	96.0	6.8	90.2	15.5	12.0	1.1
Avg.	93.4	86.6	6.8	6.7	0.5	95.9	98.6	99.2	7.0	94.5	10.4	10.2	0.7
Std Dv	1.4	2.3	1.0	0.6	0.0	1.4	2.3	2.1	0.7	2.8	2.5	1.5	0.2
90% CI	1.1	1.7	0.7	0.4	0.0	1.1	1.7	1.5	0.6	2.0	1.8	1.2	0.2
6 DEGREE APPROACH -- TARGET IAS 74 KTS													
I50	95.1	90.1	5.0	5.7	0.4	98.1	103.1	103.7	5.7	99.6	7.5	6.0	0.6
I51	94.5	88.7	5.9	6.7	0.5	98.1	101.1	102.1	6.9	97.9	7.5	7.5	1.0
I52	95.4	88.6	6.7	6.6	0.4	-	101.1	101.9	-	97.1	10.5	-	0.9
I53	96.2	91.5	4.6	5.3	0.4	99.2	103.7	104.2	5.6	99.4	7.5	7.5	0.7
I54	93.1	87.4	5.7	5.7	0.4	96.6	100.6	101.4	5.4	97.9	10.0	9.0	0.8
I55	92.8	85.4	7.4	7.1	0.5	96.3	99.1	99.9	6.4	95.8	11.0	10.0	0.7
Avg.	94.5	88.6	5.9	6.2	0.4	97.7	101.4	102.2	6.0	98.0	9.0	8.0	0.8
Std Dv	1.3	2.1	1.0	0.7	0.1	1.2	1.7	1.6	0.6	1.4	1.7	1.5	0.1
90% CI	1.1	1.7	0.9	0.6	0.0	1.2	1.4	1.3	0.6	1.2	1.4	1.5	0.1
9 DEGREE APPROACH -- TARGET IAS 74 KTS													
K61	86.9	79.9	7.0	7.1	0.5	-	92.9	93.6	-	92.6	9.5	-	0.6
K62	88.2	79.9	8.2	7.6	0.6	-	92.9	93.4	-	89.5	12.0	-	0.5
K63	90.4	84.5	5.9	6.2	0.4	94.6	98.6	99.8	5.4	95.6	9.0	8.0	1.2
K64	86.6	80.4	6.2	6.3	0.4	90.4	92.9	93.9	6.8	91.6	9.5	9.0	1.4
K65	86.9	79.6	7.3	6.8	0.5	-	92.1	92.8	-	89.9	12.0	-	0.7
K66	86.8	80.0	6.8	6.4	0.4	90.4	92.6	93.6	6.5	91.2	11.5	11.0	0.7
Avg.	87.6	80.7	6.9	6.8	0.5	91.8	93.7	94.5	6.2	91.7	10.6	9.3	0.9
Std Dv	1.5	1.9	0.8	0.5	0.1	2.4	2.4	2.6	0.8	2.2	1.4	1.5	0.3
90% CI	1.2	1.5	0.7	0.4	0.0	4.1	2.0	2.1	1.3	1.8	1.1	2.6	0.3

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.4-5.3

SIKORSKY S-76 HELICOPTER (SPIRIT)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
5/7/84

SITE: 5 CENTERLINE - 188 M. EAST JUNE 13,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	DASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 145 KTS													
A1	88.8	83.4	5.4	6.1	0.5	91.9	95.9	96.4	6.2	98.3	7.5	7.5	1.0
A2	89.1	83.5	5.6	6.2	0.5	91.9	95.6	96.4	6.3	97.5	8.0	7.5	0.8
A3	88.9	83.3	5.6	6.4	0.5	92.0	95.9	96.6	6.2	99.9	7.5	7.5	0.7
A5	88.6	83.2	5.4	6.4	0.5	91.7	95.5	96.3	6.3	98.4	7.0	7.0	1.2
A6	90.8	84.9	5.9	6.5	0.5	93.7	97.2	97.9	6.2	100.1	8.0	8.5	0.7
Avg.	89.2	83.7	5.6	6.3	0.5	92.2	96.0	96.7	6.3	98.9	7.6	7.6	0.9
Std Dv	0.9	0.7	0.2	0.1	0.0	0.8	0.7	0.6	0.0	1.1	0.4	0.5	0.2
90% CI	0.8	0.7	0.2	0.1	0.0	0.8	0.7	0.6	0.0	1.1	0.4	0.5	0.2
500 FT. FLYOVER -- TARGET IAS 130 KTS													
B7	86.9	81.0	5.8	6.3	0.5	90.2	93.2	94.3	6.6	92.7	8.5	8.0	1.1
B8	88.2	82.1	6.1	6.6	0.5	91.0	94.2	95.0	6.6	94.1	8.5	8.0	0.9
B9	86.1	80.0	6.1	6.6	0.5	89.3	92.1	93.1	6.6	92.4	8.5	8.5	1.1
B10	87.2	80.8	6.3	6.6	0.5	90.1	92.9	93.9	6.3	92.9	9.0	9.5	1.0
B11	86.9	81.2	5.8	6.4	0.5	89.8	93.1	93.9	6.5	95.2	8.0	8.0	0.7
B12	87.8	82.2	5.6	6.2	0.5	90.4	93.7	94.6	6.6	94.3	8.0	7.5	1.0
B13	85.4	79.0	6.4	6.7	0.5	88.2	90.8	91.8	6.7	92.6	9.0	9.0	1.2
Avg.	86.9	80.9	6.0	6.5	0.5	89.9	92.9	93.8	6.6	93.4	8.5	8.4	1.0
Std Dv	1.0	1.1	0.3	0.2	0.0	0.9	1.1	1.1	0.1	1.1	0.4	0.7	0.2
90% CI	0.7	0.8	0.2	0.1	0.0	0.7	0.8	0.8	0.1	0.8	0.3	0.5	0.1
500 FT. FLYOVER -- TARGET IAS 115 KTS													
C14	86.5	79.9	6.6	6.4	0.4	89.3	91.7	92.9	6.4	87.0	11.0	10.0	1.1
C15	85.9	80.0	5.9	6.2	0.4	88.8	92.0	93.2	6.0	87.3	9.0	8.5	1.3
C17	84.4	78.3	6.1	6.6	0.5	87.2	90.1	91.2	6.7	89.9	8.5	8.0	1.1
C18	85.8	79.3	6.5	6.5	0.4	88.6	91.2	92.3	6.4	87.5	10.0	9.5	1.1
Avg.	85.7	79.4	6.3	6.4	0.4	88.5	91.2	92.4	6.4	87.9	9.6	9.0	1.2
Std Dv	0.9	0.8	0.3	0.2	0.0	0.9	0.8	0.9	0.3	1.4	1.1	0.9	0.1
90% CI	1.0	0.9	0.4	0.2	0.0	1.0	1.0	1.1	0.3	1.6	1.3	1.1	0.1
500 FT. FLYOVER -- TARGET IAS 100 KTS													
D19	84.3	77.0	7.3	6.5	0.4	87.2	89.5	90.4	6.4	81.8	13.0	12.0	0.9
D20	85.7	78.5	7.3	6.7	0.4	88.7	90.9	92.1	6.3	82.3	12.0	11.0	1.2
D21	84.0	77.4	6.6	6.7	0.5	86.9	89.7	90.6	6.7	82.3	9.5	9.0	0.9
D22	85.6	78.1	7.5	6.8	0.4	88.6	90.3	91.4	6.7	82.1	13.0	12.0	1.0
D23	85.7	78.8	7.0	7.1	0.5	88.4	90.8	91.6	6.9	83.8	9.5	9.5	0.9
Avg.	85.1	78.0	7.1	6.8	0.5	88.0	90.2	91.2	6.6	82.5	11.4	10.7	1.0
Std Dv	0.9	0.7	0.4	0.2	0.0	0.8	0.6	0.7	0.2	0.8	1.8	1.4	0.2
90% CI	0.8	0.7	0.4	0.2	0.0	0.8	0.6	0.7	0.2	0.8	1.7	1.3	0.2
1000 FT. FLYOVER -- TARGET IAS 145 KTS													
E24	83.1	74.9	8.2	6.8	0.4	-	85.9	86.9	-	93.1	15.5	-	1.0
E25	83.9	73.9	10.0	8.0	0.6	-	85.4	86.4	-	92.0	17.5	-	1.0
E26	82.9	74.3	8.6	7.3	0.5	85.3	85.2	86.2	7.3	92.8	15.5	17.0	1.0
E27	85.2	77.0	8.2	7.1	0.5	87.3	88.3	88.8	7.3	94.2	14.0	14.5	0.5
E28	83.5	75.1	8.5	7.2	0.5	85.7	85.8	87.1	7.1	93.4	15.0	16.5	1.3
Avg.	83.7	75.0	8.7	7.3	0.5	86.1	86.1	87.1	7.2	93.1	15.5	16.0	1.0
Std Dv	0.9	1.2	0.7	0.4	0.1	1.1	1.2	1.0	0.1	0.8	1.3	1.3	0.3
90% CI	0.8	1.1	0.7	0.4	0.1	1.8	1.2	1.0	0.2	0.7	1.2	2.2	0.3

APPENDIX B

Direct Read Acoustical Data and Duration Factors for Flight Operations

In addition to the magnetic recording systems, four direct-read, Type-1 noise measurement systems were deployed at selected sites during flight operations. The data acquisition is described in Section 5.6.2.

These direct read systems collected single event data consisting of maximum A-weighted sound level (AL), Sound Exposure Level (SEL), integration time (T), and equivalent sound level (LEQ). The SEL and dBA, as well as the integration time were put into a computer data file and analyzed to determine two figures of merit related to the event duration influence on the SEL energy dose metric. The data reduction is further described in Section 6.2.2; the analysis of these data is discussed in Section 9.3.

This appendix presents direct read data and contains the results of the helicopter noise duration effect analysis for flight operations. The direct read acoustical data for static operations is presented in Appendix D.

Each table within this appendix provides the following information:

Run No.	The test run number
SEL(dB)	Sound Exposure Level, expressed in decibels
AL(dB)	A-Weighted Sound Level, expressed in decibels
T(10-dB)	Integration time
K(A)	Propagation constant describing the change in dBA with distance
Q	Time history "shape factor"
Average	The average of the column
N	Sample size
Std Dev	Standard Deviation
90% C.I.	Ninety percent confidence interval
Mic Site	The centerline mircophone site at which the measurements were taken

TABLE B.1.1

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT FLYOVER(1.0*VNE)/TARGET IAS=145 KTS

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
A1	89.8	84.8	7	5.9	.5
A2	89.6	84	8	6.2	.5
A3	89.8	84.2	8	6.2	.5
A4	91.3	86	7	6.3	.5
A5	89.1	84	7	6	.5
A6	91.5	85.8	8	6.3	.5
AVERAGE	90.20	84.80	7.50	6.20	.5
N	6	6	6	6	6
STD.DEV.	0.98	0.90	0.55	.15	.01
90% C.I.	0.81	0.74	0.45	.12	.01

TABLE B.1.2

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT FLYOVER(1.0*VNE)/TARGET IAS=145 KTS

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
A1	90.8	85	7	6.9	.5
A2	90.6	84.1	9	6.8	.5
A3	90.9	85.6	6	6.8	.6
A4	NA	NA	NA	NA	NA
A5	90.3	84.6	8	6.3	.5
A6	92	85.6	7	7.6	.6
AVERAGE	90.90	85.00	7.40	6.90	.5
N	5	5	5	5	5
STD.DEV.	0.65	0.65	1.14	.45	.06
90% C.I.	0.62	0.62	1.09	.43	.06

TABLE B.1.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT FLYOVER(1.0*VNE)/TARGET IAS=145 KTS

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
A1	90.7	85.2	8	6.1	.4
A2	90.4	84.1	9	6.6	.5
A3	90.5	84.5	7	7.1	.6
A4	91.3	85.3	7	7.1	.6
A5	90.7	84.6	8	6.8	.5
A6	90.9	84.5	8	7.1	.6
AVERAGE	90.80	84.70	7.80	6.80	.5
N	6	6	6	6	6
STD.DEV.	0.32	0.46	0.75	.4	.05
90% C.I.	0.26	0.38	0.62	.33	.04

TABLE B.2.1

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT FLYOVER(0.9*VNE)/TARGET IAS=130 KTS

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
B7	86.9	81.4	9	5.8	.4
B8	88.8	83	8	6.4	.5
B9	86.9	80.8	9	6.4	.5
B10	87.9	81.5	9	6.7	.5
B11	87.7	82.1	7	6.6	.5
B12	88.7	83	7	6.7	.5
B13	NA	NA	9	NA	NA
AVERAGE	87.80	82.00	8.30	6.40	.5
N	6	6	7	6	6
STD.DEV.	0.83	0.90	0.95	.36	.05
90% C.I.	0.68	0.74	0.70	.3	.04

TABLE B.2.2

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT FLYOVER(0.9*VNE)/TARGET IAS=130 KTS

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
B7	88.3	82.1	9	6.5	.5
B8	89.6	82.6	9	7.3	.6
B9	87.6	81.4	8	6.9	.5
B10	88.5	81.6	9	7.2	.5
B11	88.8	82.9	8	6.5	.5
B12	89.4	83.1	8	7	.5
B13	86.7	80.8	8	6.5	.5
AVERAGE	88.40	82.10	8.40	6.90	.5
N	7	7	7	7	7
STD.DEV.	1.01	0.85	0.53	.35	.03
90% C.I.	0.74	0.62	0.39	.25	.03

TABLE B.2.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT FLYOVER(0.9*VNE)/TARGET IAS=130 KTS

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
B7	88.4	82.5	8	6.5	.5
B8	88.7	82.1	9	6.9	.5
B9	87.6	81.2	9	6.7	.5
B10	88.1	81.3	10	6.8	.5
B11	88.5	82.1	NA	NA	NA
B12	89.1	82.8	9	6.6	.5
B13	86.8	80.4	9	6.7	.5
AVERAGE	88.20	81.80	9.00	6.70	.5
N	7	7	6	6	6
STD.DEV.	0.77	0.84	0.63	.14	.01
90% C.I.	0.56	0.62	0.52	.11	.01

TABLE B.3.1

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT FLYOVER(0.8*VNE)/TARGET IAS=115 KTS

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
C14	87.2	80.6	10	6.6	.5
C15	86.8	80.8	9	6.3	.4
C16	86.1	79.1	11	6.7	.5
C17	85.2	79.2	9	6.3	.4
C18	86.7	80.1	10	6.6	.5
AVERAGE	86.40	80.00	9.80	6.50	.5
N	5	5	5	5	5
STD.DEV.	0.78	0.78	0.84	.2	.01
90% C.I.	0.74	0.75	0.80	.19	.01

TABLE B.3.2

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT FLYOVER(0.8*VNE)/TARGET IAS=115 KTS

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
C14	87.5	80.2	10	7.3	.5
C15	87.3	81.2	8	6.8	.5
C16	86.7	79.2	10	7.5	.6
C17	85.5	79.4	8	6.8	.5
C18	87.3	80.3	10	7	.5
AVERAGE	86.90	80.10	9.20	7.10	.5
N	5	5	5	5	5
STD.DEV.	0.82	0.80	1.10	.33	.03
90% C.I.	0.78	0.76	1.04	.32	.02

TABLE B.3.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT FLYOVER(0.8*VNE)/TARGET IAS=115 KTS

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
C14	86.3	78.7	12	7	.5
C15	87.1	80.5	9	6.9	.5
C16	86.4	78.7	11	7.4	.5
C17	85	78.6	8	7.1	.6
C18	87.1	80	10	7.1	.5
AVERAGE	86.40	79.30	10.00	7.10	.5
N	5	5	5	5	5
STD.DEV.	0.86	0.89	1.58	.18	.03
90% C.I.	0.82	0.84	1.51	.17	.03

TABLE B.4.1

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT FLYOVER(0.7*VNE)/TARGET IAS=100 KTS

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
D19	85	77.8	14	6.3	.4
D20	86.6	78.9	13	6.9	.5
D21	84.7	78.3	10	6.4	.4
D22	86.3	78.8	13	6.7	.4
D23	86.5	79.6	10	6.9	.5
AVERAGE	85.80	78.70	12.00	6.60	.4
N	5	5	5	5	5
STD.DEV.	0.90	0.68	1.87	.29	.04
90% C.I.	0.86	0.64	1.78	.28	.04

TABLE B.4.2

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT FLYOVER(0.7*VNE)/TARGET IAS=100 KTS

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
D19	86.6	77.5	13	8.2	.6
D20	87.5	79.9	11	7.3	.5
D21	85.3	78.6	10	6.7	.5
D22	86.9	78.9	13	7.2	.5
D23	87.5	81.2	8	7	.5
AVERAGE	86.80	79.20	11.00	7.30	.5
N	5	5	5	5	5
STD.DEV.	0.90	1.40	2.12	.55	.06
90% C.I.	0.86	1.33	2.02	.53	.06

TABLE B.4.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT FLYOVER(0.7*VNE)/TARGET IAS=100 KTS

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
D19	87.5	81.1	9	6.7	.5
D20	86.8	78.6	13	7.4	.5
D21	84.8	77.5	10	7.3	.5
D22	86.5	78.4	12	7.5	.5
D23	86.3	79.1	10	7.2	.5
AVERAGE	86.40	78.90	10.80	7.20	.5
N	5	5	5	5	5
STD.DEV.	0.99	1.34	1.64	.3	.02
90% C.I.	0.95	1.28	1.57	.29	.02

TABLE B.5.1

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 1000 FT.FLYOVER(1.0*VNE)/TARGET IAS=145 KTS

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
E24	84.1	75.8	16	6.9	.4
E25	84.8	74.8	17	8.1	.6
E26	84	75.5	16	7.1	.4
E27	85.8	77.5	14	7.2	.5
E28	84.1	75.6	15	7.2	.5
AVERAGE	84.60	75.80	15.60	7.30	.5
N	5	5	5	5	5
STD.DEV.	0.76	1.00	1.14	.48	.06
90% C.I.	0.73	0.95	1.09	.46	.06

TABLE B.5.2

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 1000 FT.FLYOVER(1.0*VNE)/TARGET IAS=145 KTS

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
E24	84.9	76.2	15	7.4	.5
E25	85	75	19	7.8	.5
E26	84.8	76.4	14	7.3	.5
E27	86.2	77.7	15	7.2	.5
E28	84.8	76.6	12	7.6	.6
AVERAGE	85.10	76.40	15.00	7.50	.5
N	5	5	5	5	5
STD.DEV.	0.60	0.97	2.55	.24	.03
90% C.I.	0.57	0.92	2.43	.23	.03

TABLE B.5.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 1000 FT.FLYOVER(1.0*VNE)/TARGET IAS=145 KTS

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
E24	84.4	76.1	15	7.1	.5
E25	84.3	74.8	20	7.3	.5
E26	84.2	75.7	14	7.4	.5
E27	85.8	77.6	14	7.2	.5
E28	84.4	76	15	7.1	.5
AVERAGE	84.60	76.00	15.60	7.20	.5
N	5	5	5	5	5
STD.DEV.	0.66	1.01	2.51	.14	.02
90% C.I.	0.63	0.96	2.39	.14	.02

TABLE B.6.1

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: ICAO TAKEOFF/TARGET IAS=74 KTS

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
F29	87.1	80	9	7.4	.6
F30	87.5	80.2	10	7.3	.5
F31	88.5	81.4	9	7.4	.6
F32	86.4	79.9	10	6.5	.4
F33	86.9	80.8	9	6.4	.5
F34	88.2	82.2	9	6.3	.4
F35	88.4	82.7	8	6.3	.5
F36	87.9	81.9	9	6.3	.4
AVERAGE	87.60	81.10	9.10	6.70	.5
N	8	8	8	8	8
STD.DEV.	0.76	1.07	0.64	.54	.06
90% C.I.	0.51	0.72	0.43	.36	.04

TABLE B.6.2

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: ICAO TAKEOFF/TARGET IAS=74 KTS

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
F29	85.8	78.6	NA	NA	NA
F30	87.3	79	12	7.7	.6
F31	88.2	80.2	11	7.7	.6
F32	86.5	78.4	11	7.8	.6
F33	86.9	79.2	10	7.7	.6
F34	86.4	78.7	12	7.1	.5
F35	86.8	80	9	7.1	.5
F36	86.6	79	11	7.3	.5
AVERAGE	86.80	79.10	10.90	7.50	.6
N	8	8	7	7	7
STD.DEV.	0.71	0.65	1.07	.29	.04
90% C.I.	0.47	0.43	0.79	.21	.03

TABLE B.6.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: ICAO TAKEOFF/TARGET IAS=74 KTS

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
F29	NA	NA	13	NA	NA
F30	86.3	77.8	13	7.6	.5
F31	86.3	77.3	14	7.9	.6
F32	85.2	76.2	14	7.9	.6
F33	85.5	77.3	12	7.6	.6
F34	84.5	76.2	13	7.5	.5
F35	85.6	77.5	12	7.5	.5
F36	84.9	75.8	13	8.2	.6
AVERAGE	85.50	76.90	13.00	7.70	.6
N	7	7	8	7	7
STD.DEV.	0.68	0.78	0.76	.25	.04
90% C.I.	0.50	0.57	0.51	.18	.03

TABLE B.7.1

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 3 DEGREE APPROACH/TARGET IAS=74 KTS

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
637	94.4	87.4	10	7	.5
638	95.3	90.5	8	5.3	.4
639	95	88.6	9	6.7	.5
640	93.2	86.6	9	6.9	.5
641	93.1	86.3	10	6.8	.5
642	94.6	87.5	9	7.4	.6
643	90.1	82.6	15	6.4	.4
AVERAGE	93.70	87.10	10.00	6.70	.5
N	7	7	7	7	7
STD.DEV.	1.78	2.42	2.31	.67	.07
90% C.I.	1.31	1.78	1.70	.49	.05

TABLE B.7.2

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 3 DEGREE APPROACH/TARGET IAS=74 KTS

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
637	94.1	87.7	8	7.1	.5
638	95.4	89.5	8	6.5	.5
639	92.6	86.7	7	7	.6
640	92.5	86.3	9	6.5	.5
641	95.6	88.9	9	7	.5
642	93.4	86	11	7.1	.5
643	90.5	82.8	12	7.1	.5
AVERAGE	93.40	86.80	9.10	6.90	.5
N	7	7	7	7	7
STD.DEV.	1.79	2.21	1.77	.27	.03
90% C.I.	1.31	1.63	1.30	.2	.02

TABLE B.7.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 3 DEGREE APPROACH/TARGET IAS=74 KTS

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
G37	91.6	84.8	9	7.1	.5
G38	94.1	86.4	10	7.7	.6
G39	87.8	79.4	11	8.1	.6
G40	90.8	84	10	6.8	.5
G41	94.3	87.1	10	7.2	.5
G42	91	83.9	12	6.6	.4
G43	91.7	85.1	9	6.9	.5
AVERAGE	91.60	84.40	10.10	7.20	.5
N	7	7	7	7	7
STD.DEV.	2.20	2.49	1.07	.52	.07
90% C.I.	1.61	1.83	0.79	.38	.05

TABLE B.8.1

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: TAKEOFF/CATAGORY B

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
H44	88.4	81.6	10	6.8	.5
H45	87.4	79.8	13	6.8	.4
H46	87.9	79.6	13	7.5	.5
H47	87.1	78.1	14	7.9	.6
H48	87.9	80.4	12	6.9	.5
H49	87.5	79.3	14	7.2	.5
AVERAGE	87.70	79.80	12.70	7.20	.5
N	6	6	6	6	6
STD.DEV.	0.46	1.16	1.51	.41	.04
90% C.I.	0.38	0.96	1.24	.34	.04

TABLE B.8.2

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: TAKEOFF/CATAGORY B

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
H44	88.5	81.5	9	7.3	.6
H45	88.5	81.4	10	7.1	.5
H46	88.6	81.7	9	7.2	.5
H47	86.7	78	15	7.4	.5
H48	86.5	78	12	7.9	.6
H49	86.5	78.2	15	7.1	.5
AVERAGE	87.60	79.80	11.70	7.30	.5
N	6	6	6	6	6
STD.DEV.	1.08	1.90	2.80	.3	.05
90% C.I.	0.89	1.57	2.31	.24	.04

TABLE B.8.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: TAKEOFF/CATAGORY B

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
H44	86.7	78.8	10	7.9	.6
H45	87.1	79.1	12	7.4	.5
H46	87.7	79.7	13	7.2	.5
H47	86.7	78.7	13	7.2	.5
H48	85.5	76	15	8.1	.6
H49	86.9	79.3	12	7	.5
AVERAGE	86.80	78.60	12.50	7.50	.5
N	6	6	6	6	6
STD.DEV.	0.72	1.32	1.64	.43	.06
90% C.I.	0.59	1.09	1.35	.35	.05

TABLE B.8.2

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: TAKEOFF/CATAGORY B

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
H44	88.5	81.5	9	7.3	.6
H45	88.5	81.4	10	7.1	.5
H46	88.6	81.7	9	7.2	.5
H47	86.7	78	15	7.4	.5
H48	86.5	78	12	7.9	.6
H49	86.5	78.2	15	7.1	.5
AVERAGE	87.60	79.80	11.70	7.30	.5
N	6	6	6	6	6
STD.DEV.	1.08	1.90	2.80	.3	.05
90% C.I.	0.89	1.57	2.31	.24	.04

TABLE B.8.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: TAKEOFF/CATAGORY B

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
H44	86.7	78.8	10	7.9	.6
H45	87.1	79.1	12	7.4	.5
H46	87.7	79.7	13	7.2	.5
H47	86.7	78.7	13	7.2	.5
H48	85.5	76	15	8.1	.6
H49	86.9	79.3	12	7	.5
AVERAGE	86.80	78.60	12.50	7.50	.5
N	6	6	6	6	6
STD.DEV.	0.72	1.32	1.64	.43	.06
90% C.I.	0.59	1.09	1.35	.35	.05

TABLE B.9.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=74 KTS

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
I50	93.7	88.6	9	5.3	.4
I51	92.5	85.1	13	6.6	.4
I52	92.6	85	15	6.5	.4
I53	92.9	83.4	16	7.9	.6
I54	94	86.4	12	7	.5
I55	93.3	87.6	9	6	.4
AVERAGE	93.20	86.00	12.30	6.60	.4
N	6	6	6	6	6
STD.DEV.	0.61	1.90	2.94	.88	.07
90% C.I.	0.50	1.56	2.42	.72	.06

TABLE B.10.1

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: TAKEOFF/TARGET IAS=74 KTS

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
J56	89	82.4	8	7.3	.6
J57	NA	NA	10	NA	NA
J58	89.4	82.7	9	7	.5
J59	89.4	83.4	9	6.3	.4
J60	90.2	84.8	9	5.7	.4
AVERAGE	89.50	83.30	9.00	6.60	.5
N	4	4	5	4	4
STD.DEV.	0.50	1.07	0.71	.74	.08
90% C.I.	0.59	1.26	0.67	.87	.1

TABLE B.10.2

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: TAKEOFF/TARGET IAS=74 KTS

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
J56	86.8	79.1	10	7.7	.6
J57	86.4	78.4	11	7.7	.6
J58	87	79.7	10	7.3	.5
J59	87	80.1	10	6.9	.5
J60	88.2	81.1	10	7.1	.5
AVERAGE	87.10	79.70	10.20	7.30	.5
N	5	5	5	5	5
STD.DEV.	0.67	1.02	0.45	.35	.04
90% C.I.	0.64	0.97	0.43	.34	.04

TABLE B.10.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: TAKEOFF/TARGET IAS=74 KTS

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
J56	84.5	76.8	11	7.4	.5
J57	83.5	75.1	14	7.3	.5
J58	84.7	77	12	7.1	.5
J59	85.6	78.4	11	6.9	.5
J60	86.9	78.9	12	7.4	.5
AVERAGE	85.00	77.20	12.00	7.20	.5
N	5	5	5	5	5
STD.DEV.	1.28	1.49	1.22	.21	.03
90% C.I.	1.22	1.42	1.17	.2	.03

TABLE B.11.1

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 9 DEGREE APPROACH/TARGET IAS=74 KTS

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
K61	87.5	80.5	12	6.5	.4
K62	89.2	81.3	12	7.3	.5
K63	91.9	85.8	9	6.4	.5
K64	87.7	81.7	9	6.3	.4
K65	88.1	81.1	12	6.5	.4
K66	88.2	81.5	12	6.2	.4
AVERAGE	88.80	82.00	11.00	6.50	.4
N	6	6	6	6	6
STD.DEV.	1.64	1.91	1.55	.4	.04
90% C.I.	1.35	1.57	1.27	.33	.04

TABLE B.11.2

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 9 DEGREE APPROACH/TARGET IAS=74 KTS

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
K61	85.7	77.9	11	7.5	.5
K62	90	81.3	14	7.6	.5
K63	87.5	78.5	23	6.6	.3
K64	85.9	77.5	12	7.8	.6
K65	87.7	80.9	9	7.1	.5
K66	86.5	78.2	12	7.7	.6
AVERAGE	87.20	79.10	13.50	7.40	.5
N	6	6	6	6	6
STD.DEV.	1.59	1.63	4.93	.44	.09
90% C.I.	1.31	1.34	4.06	.36	.07

TABLE B.11.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 9 DEGREE APPROACH/TARGET IAS=74 KTS

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
K61	84.7	75.5	15	7.8	.6
K62	91.6	83.9	12	7.1	.5
K63	87	76.4	21	8	.6
K64	87.1	77.6	26	6.7	.3
K65	88.7	81.2	14	6.5	.4
K66	86.8	77.9	22	6.6	.4
AVERAGE	87.70	78.80	18.30	7.10	.4
N	6	6	6	6	6
STD.DEV.	2.32	3.18	5.47	.64	.1
90% C.I.	1.91	2.62	4.50	.52	.08

APPENDIX C

Magnetic Recording Acoustical Data for Static Operations

This appendix contains time averaged, A-weighted sound level data along with time averaged, one-third octave sound pressure level information for eight different directivity emission angles. These data were acquired June 6 using the TSC magnetic recording system discussed in Section 5.6.1.

Thirty-two seconds of corrected raw spectral data (64 contiguous 1/2 second data records) have been energy averaged to produce the data tabulated in this appendix. The spectral data presented are "As Measured" for the given emission angles established relative to each microphone location. Also included in the tables are the 360 degree (eight emission angle) average levels, calculated by both arithmetic and energy averaging. The data reduction is further described in Section 6.1. Figure 6.1 (previously shown) provides the reader with a quick reference to the emission angle convention.

The data contained in these tables have been used in analyses presented in Sections 9.2 and 9.7. The reader may cross reference the magnetic recording data of this appendix with direct read static data presented in Appendix D.

Appendix C

"As Measured" 1/3 Octave Noise Data--Static Test are presented.

The key to the table numbering system is as follows:

Table No. C. 1-1H. 1

Appendix No.

Helicopter No. & Microphone Location

Page No. of Group

Table No.

C.1-X.X	Aerospatiale	SA-365N (Dauphin)
C.2-X.X	Aerospatiale	SA-355F (Twinstar)
C.3-X.X	Aerospatiale	AS-350D (Astar)
C.4-X.X	Sikorsky	S-76 (Spirit)
C.5-X.X	Bell	222
C.6-X.X	Hughes	500D
C.7-X.X	Boeing Vertol	CH-470D (Shinook)

Microphone No.

1H	(soft)	150 m northwest
2	(soft)	150 m west
4H	(soft)	300 m west
5H	(hard)	150 m north

Page No.

1	Hover-in-Ground-Effect
2	Flight Idle
3	Ground Idle
4	Hover-Out-of-Ground-Effect

TABLE NO. C.4-1H.1

SIKORSKY S-76 HELICOPTER (SPIRIT)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 1H (SOFT) -- 150 M. NW JUNE 13,1983

HOVER-IN-GROUND-EFFECT

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES)								AVERAGE LEVEL OVER 360 DEGREES			
	0	45	90	135	180	225	270	315	ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	54.7	58.8	58.5	55.6	57.5	58.2	54.7	51.8	56.8	12.1	56.2	2.4
15	57.7	57.9	61.8	63.0	57.8	57.7	57.5	54.6	59.3	19.9	58.5	2.7
16	72.1	70.9	75.6	76.4	68.8	70.3	70.7	68.1	72.6	38.0	71.6	3.0
17	57.4	57.0	63.2	67.3	64.0	61.7	60.1	53.3	62.3	32.1	60.5	4.5
18	64.8	62.1	70.8	75.8	72.4	69.4	66.8	58.7	70.3	44.1	67.6	5.6
19	62.0	62.3	69.6	73.8	74.1	70.8	67.8	60.1	70.1	47.6	67.6	5.5
20	69.6	71.8	81.8	81.3	80.4	81.1	81.9	80.7	80.1	61.0	78.6	4.9
21	64.5	66.1	73.0	76.9	78.9	74.1	73.3	70.7	74.2	58.1	72.2	4.9
22	62.7	63.6	67.4	76.3	78.0	71.5	69.7	63.4	72.5	59.1	69.1	5.9
23	61.1	67.5	71.7	76.9	76.5	72.4	71.6	71.7	73.1	62.2	71.2	5.0
24	57.6	61.5	64.5	72.3	71.1	66.7	66.0	64.5	67.6	59.0	65.5	4.8
25	53.5	54.6	58.0	62.3	65.0	61.0	56.6	59.4	60.3	53.7	58.8	3.9
26	49.9	49.9	52.8	57.8	63.2	58.8	50.1	51.8	57.1	52.3	54.3	5.0
27	49.3	50.3	53.6	57.1	63.0	56.3	52.9	51.2	56.6	53.4	54.2	4.5
28	49.9	51.3	54.9	58.1	63.9	54.9	56.6	55.3	57.7	55.8	55.6	4.3
29	51.0	52.4	56.1	58.4	64.0	56.1	58.3	59.5	58.7	57.9	57.0	4.1
30	51.2	52.5	56.5	59.2	64.2	55.9	58.6	58.5	58.8	58.9	57.1	4.1
31	51.0	52.3	56.4	58.7	63.2	54.9	58.6	57.7	58.1	58.7	56.6	3.9
32	49.9	51.0	55.5	58.1	61.9	54.1	58.5	56.1	57.1	58.1	55.6	4.0
33	48.7	49.9	54.6	56.9	60.5	52.6	57.2	55.0	55.9	57.1	54.4	3.9
34	48.5	49.1	53.6	55.6	58.5	51.1	55.8	54.0	54.4	55.7	53.3	3.5
35	48.0	47.6	52.2	53.5	56.2	49.2	53.9	52.4	52.5	53.7	51.6	3.1
36	46.6	45.9	51.0	52.3	55.1	47.7	53.2	50.8	51.4	52.4	50.3	3.3
37	45.1	43.8	49.1	49.9	52.6	45.0	51.8	48.2	49.2	49.7	48.2	3.3
38	43.7	41.6	47.0	47.6	50.2	42.1	49.6	45.8	46.9	46.8	45.9	3.3
39	41.3	38.6	43.5	44.3	46.7	38.4	46.1	42.4	43.6	42.5	42.7	3.1
40	36.0	33.2	38.1	39.9	41.5	34.2	40.8	37.2	38.5	36.0	37.6	3.0
AL	62.0	63.8	68.9	72.4	74.5	69.0	70.1	69.0	70.2	70.2	68.7	4.1
OASPL	75.9	76.8	84.2	86.1	85.9	83.6	83.7	82.1	83.5	-	82.3	3.9
PNL	76.2	78.0	85.6	87.6	88.8	85.2	86.3	84.6	85.8	-	94.0	4.5
PNLT	77.3	79.3	87.4	88.6	89.5	86.6	88.1	87.1	87.1	-	85.5	4.6

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.4-1H.2

SIKORSKY S-76 HELICOPTER (SPIRIT)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 1H (SOFT) - 150 M. NW JUNE 13,1983

FLIGHT IDLE

BAND NO.	M3 0	M1 45	M8 90	135	180	ML 225	M5 270	M4 315	ENERGY *	AVE **	ARITH ***	Std Dv
	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) — SOUND PRESSURE LEVEL dB re 20 microPascal								AVERAGE LEVEL OVER 360 DEGREES			
14	51.4	52.4	50.8	-	-	52.3	51.6	51.3	51.7	7.0	51.6	0.6
15	48.5	48.5	49.8	-	-	49.5	54.3	50.0	50.6	11.2	50.1	2.2
16	66.9	64.5	64.0	-	-	64.6	68.7	66.9	66.3	31.7	65.9	1.8
17	49.9	50.0	50.0	-	-	52.5	57.9	49.8	53.0	22.8	51.7	3.2
18	58.2	54.9	55.3	-	-	59.2	64.8	52.2	59.5	33.3	57.4	4.4
19	51.4	56.3	57.1	-	-	57.4	61.5	56.3	57.6	35.1	56.7	3.2
20	70.9	64.7	73.3	-	-	71.2	73.4	73.4	71.9	52.8	71.1	3.4
21	63.1	58.8	63.7	-	-	62.2	64.2	65.3	63.3	47.2	62.9	2.3
22	54.7	55.5	57.8	-	-	58.0	59.9	56.2	57.4	44.0	57.0	1.9
23	54.5	60.9	61.2	-	-	63.0	63.1	59.7	61.1	50.2	60.4	3.2
24	51.3	55.4	56.7	-	-	57.4	57.8	53.9	55.9	47.3	55.4	2.5
25	46.7	48.4	50.7	-	-	50.7	52.2	49.9	50.1	43.5	49.8	1.9
26	42.9	40.6	41.8	-	-	42.2	43.7	43.2	42.5	37.7	42.4	1.1
27	41.4	39.4	39.8	-	-	41.6	42.4	41.4	41.1	37.9	41.0	1.2
28	40.7	37.9	39.6	-	-	44.3	43.7	41.3	41.8	39.9	41.2	2.4
29	41.8	38.8	40.6	-	-	47.6	44.8	42.1	43.6	42.8	42.6	3.1
30	41.0	38.6	40.1	-	-	46.6	43.7	40.9	42.7	42.7	41.8	2.9
31	40.4	38.4	39.5	-	-	45.4	44.5	41.4	42.4	43.0	41.6	2.8
32	39.7	38.0	38.6	-	-	44.3	44.1	41.3	41.7	42.7	41.0	2.7
33	39.7	37.4	38.1	-	-	44.7	43.6	41.5	41.7	42.9	40.8	3.0
34	39.5	36.5	36.9	-	-	45.7	42.0	41.3	41.5	42.8	40.3	3.5
35	40.8	36.0	35.9	-	-	45.4	40.5	41.1	41.2	42.4	39.9	3.6
36	42.1	36.3	35.5	-	-	43.9	38.8	40.2	40.5	41.5	39.5	3.3
37	44.4	38.4	32.7	-	-	41.3	36.7	41.5	40.6	41.1	39.2	4.1
38	44.5	38.3	30.9	-	-	37.5	33.8	41.6	39.9	39.8	37.8	5.0
39	39.7	34.4	28.0	-	-	33.4	30.6	38.0	35.7	34.6	34.0	4.4
40	33.2	29.7	25.2	-	-	29.7	28.4	32.7	30.6	28.1	29.8	2.9
AL	56.7	55.0	58.0	-	-	59.5	59.6	58.4	58.1	58.1	57.9	1.8
OASPL	73.3	69.9	74.8	-	-	73.7	76.2	75.2	74.2	-	73.8	2.2
PNL	72.8	69.2	73.6	-	-	74.5	75.4	74.7	74.0	-	73.4	2.2
PNLT	75.1	70.4	75.7	-	-	76.4	77.2	76.8	75.9	-	75.3	2.5

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.4-1H.3

SIKORSKY S-76 HELICOPTER (SPIRIT)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 1H (SOFT) - 150 M. NW JUNE 13,1983

GROUND IDLE

	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES)								AVERAGE LEVEL OVER 360 DEGREES			
BAND NO.	0	45 (42)	90	135	180	225 (M7)	270	315	ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	--	43.0	--	--	--	47.8	--	--	46.0	1.3	45.4	3.4
15	--	45.1	--	--	--	47.1	--	--	46.2	6.8	46.1	1.4
16	--	46.4	--	--	--	46.3	--	--	46.4	11.8	46.3	0.1
17	--	46.9	--	--	--	51.9	--	--	50.1	19.9	49.4	3.5
18	--	48.0	--	--	--	52.9	--	--	51.1	24.9	50.4	3.5
19	--	48.5	--	--	--	51.1	--	--	50.0	27.5	49.8	1.8
20	--	52.6	--	--	--	57.4	--	--	55.6	36.5	55.0	3.4
21	--	49.1	--	--	--	48.6	--	--	48.9	32.8	48.9	0.4
22	--	50.9	--	--	--	51.2	--	--	51.1	37.7	51.0	0.2
23	--	52.3	--	--	--	52.4	--	--	52.4	41.5	52.3	0.1
24	--	46.5	--	--	--	51.1	--	--	49.4	40.8	48.8	3.3
25	--	37.5	--	--	--	42.8	--	--	40.9	34.3	40.1	3.7
26	--	31.0	--	--	--	36.8	--	--	34.8	30.0	33.9	4.1
27	--	29.0	--	--	--	37.0	--	--	34.6	31.4	33.0	5.7
28	--	31.9	--	--	--	35.2	--	--	33.9	32.0	33.5	2.3
29	--	30.7	--	--	--	34.0	--	--	32.7	31.9	32.3	2.3
30	--	26.1	--	--	--	31.5	--	--	29.6	29.6	28.8	3.8
31	--	28.9	--	--	--	29.6	--	--	29.3	29.9	29.2	0.5
32	--	31.3	--	--	--	30.8	--	--	31.1	32.1	31.1	0.4
33	--	33.4	--	--	--	31.5	--	--	32.6	33.8	32.4	1.3
34	--	34.2	--	--	--	29.7	--	--	32.5	33.8	31.9	3.2
35	--	35.7	--	--	--	28.6	--	--	33.5	34.7	32.1	5.0
36	--	36.6	--	--	--	29.7	--	--	34.4	35.4	33.1	4.9
37	--	36.6	--	--	--	29.0	--	--	34.3	34.8	32.8	5.4
38	--	34.6	--	--	--	27.2	--	--	32.3	32.2	30.9	5.2
39	--	33.8	--	--	--	26.0	--	--	31.5	30.4	29.9	5.5
40	--	34.3	--	--	--	25.8	--	--	31.9	29.4	30.1	6.0
AL	--	48.2	--	--	--	48.5	--	--	48.4	48.4	48.3	0.2
OASPL	--	59.6	--	--	--	62.4	--	--	61.2	--	61.0	2.0
PNL	--	61.8	--	--	--	61.4	--	--	61.8	--	61.6	0.3
PNLT	--	62.4	--	--	--	62.6	--	--	62.8	--	62.5	0.1

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.4-2H.1

SIKORSKY S-76 HELICOPTER (SPIRIT)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 2 (SOFT) - 150 M. WEST JUNE 13,1983

HOVER-IN-GROUND-EFFECT

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES)								AVERAGE LEVEL OVER 360 DEGREES			
	~1 0	~9 45	L7 90	L6 135	~5 180	L4 225	L3 270	L2 315	ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	55.6	59.8	60.1	58.3	63.4	55.2	56.2	56.5	59.0	14.3	58.1	2.8
15	59.2	59.4	65.9	66.6	64.1	53.7	60.1	58.0	62.6	23.2	60.9	4.4
16	74.0	72.4	80.1	80.5	75.6	65.7	74.4	71.1	76.3	41.7	74.2	4.8
17	59.2	59.5	67.8	71.3	69.4	56.5	60.9	57.5	66.0	35.8	62.8	5.8
18	66.1	65.3	76.2	80.3	78.8	64.1	68.0	63.4	74.8	48.6	70.3	7.0
19	63.4	68.6	74.1	78.3	78.6	66.0	64.6	64.2	73.6	51.1	69.7	6.4
20	72.8	74.9	85.1	83.9	83.8	79.3	80.4	82.3	81.8	62.7	80.3	4.5
21	67.4	71.5	77.1	81.2	80.9	72.0	72.3	73.7	76.8	60.7	74.5	4.8
22	65.4	69.6	72.1	81.1	79.0	68.6	68.3	66.2	75.0	61.6	71.3	5.8
23	65.4	71.0	77.0	81.5	78.8	69.5	69.1	76.3	76.3	65.4	73.6	5.6
24	61.4	66.0	71.2	76.8	73.6	66.5	64.0	69.5	71.2	62.6	68.6	5.1
25	59.5	63.6	65.5	70.3	71.7	64.2	56.7	68.1	67.2	60.6	64.9	5.1
26	58.0	60.1	57.7	67.0	69.3	62.8	51.6	60.0	63.7	58.9	60.8	5.6
27	55.0	57.0	55.9	65.2	65.6	59.4	53.5	57.0	60.9	57.7	58.6	4.5
28	54.2	56.5	57.5	65.5	65.5	58.5	56.4	58.8	61.1	59.2	59.1	4.2
29	55.3	57.7	58.9	66.2	66.1	64.1	57.0	64.2	62.9	62.1	61.2	4.4
30	56.5	58.0	59.2	67.6	66.0	63.8	58.6	63.6	63.3	63.3	61.7	4.1
31	55.4	57.5	58.8	66.9	65.2	62.9	58.9	62.4	62.5	63.1	61.0	4.0
32	54.2	56.7	58.5	65.5	64.1	62.2	59.8	60.8	61.5	62.5	60.2	3.8
33	52.9	55.7	58.2	64.0	62.5	60.5	58.5	59.3	60.1	61.3	58.9	3.6
34	51.5	54.8	57.0	62.3	61.0	58.9	56.9	58.0	58.6	59.9	57.5	3.4
35	50.2	54.0	55.6	60.6	59.2	56.9	55.6	56.4	57.0	58.2	56.1	3.2
36	47.1	51.5	52.6	57.5	55.7	53.6	53.7	52.8	53.9	54.9	53.1	3.1
37	44.5	49.1	50.0	54.4	52.6	50.3	51.3	49.6	51.0	51.5	50.2	2.9
38	44.8	48.9	49.4	53.5	51.6	49.3	50.4	48.9	50.2	50.1	49.6	2.5
39	41.7	45.3	45.2	49.1	47.5	44.7	46.1	44.1	46.0	44.9	45.5	2.2
40	35.5	38.5	38.5	42.9	40.9	38.2	39.1	37.7	39.4	36.9	38.9	2.2
AL	66.0	69.1	72.9	78.2	77.0	72.5	69.8	73.2	73.9	73.9	72.3	4.0
OASPL	78.5	80.4	88.1	90.2	89.0	81.8	82.8	84.6	86.1	-	84.4	4.3
PNL	79.8	83.3	89.3	93.0	91.7	86.3	85.5	87.8	88.9	-	87.1	4.3
PNLT	81.0	84.1	90.9	93.9	92.5	88.0	87.5	90.0	90.0	-	88.5	4.3

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.4-2H.2

SIKORSKY S-76 HELICOPTER (SPIRIT)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 2 (SOFT) - 150 M. WEST JUNE 13,1983

FLIGHT IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) M1 0	M4 45	90	135	M2 180	M5 225	M6 270	M3 315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	53.5	56.9	-	-	51.3	55.5	54.6	52.9	54.5	9.8	54.1	2.0
15	52.2	54.9	-	-	53.5	53.8	55.1	54.3	54.1	14.7	54.0	1.1
16	69.1	65.9	-	-	68.9	67.4	70.5	71.4	69.2	34.6	68.9	2.0
17	52.6	53.3	-	-	53.5	55.9	57.0	54.2	54.7	24.5	54.4	1.7
18	60.3	56.8	-	-	60.1	61.4	65.8	55.8	61.3	35.1	60.0	3.6
19	53.2	59.7	-	-	57.6	59.7	62.2	57.2	59.1	36.6	58.3	3.1
20	70.5	68.6	-	-	75.6	74.3	72.9	75.2	73.5	54.4	72.8	2.8
21	63.8	63.8	-	-	67.2	65.8	66.3	68.3	66.2	50.1	65.9	1.8
22	58.8	62.2	-	-	62.1	61.9	60.6	59.4	61.0	47.6	60.8	1.5
23	59.4	65.6	-	-	64.7	67.7	63.5	61.8	64.5	53.6	63.8	2.9
24	58.1	61.2	-	-	59.5	61.9	59.5	57.9	59.9	51.3	59.7	1.6
25	55.1	58.1	-	-	52.7	56.6	55.7	55.0	55.8	49.2	55.5	1.8
26	47.0	50.2	-	-	41.4	47.1	48.6	46.1	47.4	42.6	46.7	3.0
27	40.3	45.5	-	-	39.9	43.4	45.8	44.1	43.7	40.5	43.2	2.5
28	38.2	43.5	-	-	41.0	43.8	45.9	45.9	43.8	41.9	43.0	3.0
29	38.8	43.1	-	-	43.7	48.4	46.3	46.8	45.5	44.7	44.5	3.4
30	37.8	41.6	-	-	44.6	50.3	45.5	45.9	45.9	45.9	44.3	4.2
31	37.8	40.8	-	-	45.3	51.2	46.2	45.9	46.4	47.0	44.5	4.7
32	37.6	41.0	-	-	46.2	51.5	46.3	46.4	46.8	47.8	44.8	4.9
33	37.9	40.3	-	-	47.4	50.9	46.0	47.0	46.8	48.0	44.9	4.9
34	37.1	38.9	-	-	46.8	50.8	44.3	47.5	46.4	47.7	44.2	5.3
35	37.7	37.5	-	-	46.3	49.8	42.9	47.4	45.7	46.9	43.6	5.2
36	38.1	34.0	-	-	43.8	46.2	40.0	44.9	42.8	43.8	41.2	4.7
37	40.0	30.1	-	-	41.7	43.4	37.0	45.2	41.6	42.1	39.6	5.4
38	41.0	28.9	-	-	41.4	41.7	35.5	46.7	41.9	41.8	39.2	6.2
39	35.6	25.0	-	-	36.4	36.5	30.4	41.9	36.9	35.8	34.3	5.8
40	29.2	22.6	-	-	29.3	30.1	24.3	36.1	30.8	28.3	28.6	4.8
AL	57.6	60.1	-	-	61.7	63.8	60.7	61.7	61.3	61.3	60.9	2.1
OASPL	74.2	73.7	-	-	77.6	77.0	76.7	77.7	76.4	-	76.1	1.8
PNL	72.7	73.4	-	-	77.8	78.6	76.1	78.0	76.8	-	76.1	2.5
PNLT	74.7	74.6	-	-	80.0	80.5	77.5	80.1	78.6	-	77.9	2.7

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.4-2H.3

SIKORSKY S-76 HELICOPTER (SPIRIT)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 2 (SOFT) - 150 M. WEST JUNE 13,1983

GROUND IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES)								AVERAGE LEVEL OVER 360 DEGREES			
	0	45	90	135	180	225	270	315	ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	46.1	-	-	-	48.9	-	-	-	47.7	3.0	47.5	2.0
15	46.6	-	-	-	50.5	-	-	-	49.0	9.6	48.6	2.8
16	48.6	-	-	-	48.7	-	-	-	48.7	14.1	48.6	0.1
17	48.6	-	-	-	47.0	-	-	-	47.9	17.7	47.8	1.1
18	49.2	-	-	-	49.7	-	-	-	49.5	23.3	49.4	0.4
19	51.0	-	-	-	54.1	-	-	-	52.8	30.3	52.6	2.2
20	51.7	-	-	-	57.5	-	-	-	55.5	36.4	54.6	4.1
21	51.2	-	-	-	49.1	-	-	-	50.3	34.2	50.1	1.5
22	52.0	-	-	-	50.7	-	-	-	51.4	38.0	51.3	0.9
23	51.0	-	-	-	51.6	-	-	-	51.3	40.4	51.3	0.4
24	49.3	-	-	-	47.2	-	-	-	48.4	39.8	48.2	1.5
25	43.1	-	-	-	40.3	-	-	-	41.9	35.3	41.7	2.0
26	37.1	-	-	-	32.8	-	-	-	35.5	30.7	34.9	3.0
27	32.6	-	-	-	29.8	-	-	-	31.4	28.2	31.2	2.0
28	34.5	-	-	-	27.8	-	-	-	32.3	30.4	31.1	4.7
29	37.9	-	-	-	26.7	-	-	-	35.2	34.4	32.3	7.9
30	36.4	-	-	-	27.1	-	-	-	33.9	33.9	31.7	6.6
31	41.6	-	-	-	27.7	-	-	-	38.8	39.4	34.6	9.8
32	42.8	-	-	-	30.5	-	-	-	40.0	41.0	36.6	8.7
33	42.4	-	-	-	30.5	-	-	-	39.7	40.9	36.4	8.4
34	40.4	-	-	-	28.6	-	-	-	37.7	39.0	34.5	8.3
35	42.5	-	-	-	-	-	-	-	42.5	43.7	42.5	-
36	42.6	-	-	-	-	-	-	-	42.6	43.6	42.6	-
37	41.1	-	-	-	-	-	-	-	41.1	41.6	41.1	-
38	40.1	-	-	-	-	-	-	-	40.1	40.0	40.1	-
39	37.6	-	-	-	-	-	-	-	37.6	36.5	37.6	-
40	36.5	-	-	-	-	-	-	-	36.5	34.0	36.5	-
AL	53.2	-	-	-	46.6	-	-	-	52.2	52.2	49.9	4.7
OASPL	61.0	-	-	-	62.2	-	-	-	61.7	-	61.6	0.8
PNL	67.3	-	-	-	59.2	-	-	-	66.8	-	63.2	5.7
PNLT	68.0	-	-	-	60.2	-	-	-	67.6	-	64.1	5.5

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.4-4H

SIKORSKY S-76 HELICOPTER (SPIRIT)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 4H (SOFT) - 300 M. WEST JUNE 13,1983

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES)								AVERAGE LEVEL OVER 360 DEGREES			
	0	45	90	135	180	225	270	315	ENERGY *	AVE **	ARITH ***	Std Dv

SOUND PRESSURE LEVEL dB re 20 microPascal

*****NO DATA*****

TABLE NO. C.4-5H.1

SIKORSKY S-76 HELICOPTER (SPIRIT)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 5H (HARD) - 150 M. NORTH JUNE 13.1983

HOVER-IN-GROUND-EFFECT

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES)								AVERAGE LEVEL OVER 360 DEGREES			
	#43 0	42 45	90	49 135	47 180	44 225	45 270	44 315	ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	56.7	60.4	-	55.3	56.2	60.5	60.3	61.8	59.4	14.7	58.7	2.6
15	57.6	58.2	-	57.7	57.7	59.6	62.6	61.3	59.7	20.3	59.2	2.0
16	71.5	67.1	-	71.1	68.8	72.5	75.8	72.3	72.1	37.5	71.3	2.8
17	56.8	56.9	-	62.4	60.9	61.1	63.8	60.0	60.9	30.7	60.3	2.6
18	64.4	61.5	-	70.7	68.1	68.7	69.9	66.8	68.0	41.8	67.2	3.2
19	60.3	63.3	-	69.5	70.6	70.6	71.7	66.7	68.9	46.4	67.5	4.3
20	66.0	70.7	-	77.5	82.2	82.9	81.6	76.2	79.5	60.4	76.7	6.4
21	63.1	66.0	-	71.9	77.3	75.5	74.9	70.3	73.4	57.3	71.3	5.2
22	63.1	65.1	-	70.8	77.3	74.0	73.9	69.6	72.7	59.3	70.5	5.1
23	64.2	67.6	-	75.5	80.8	77.0	79.0	74.2	76.6	65.7	74.0	6.0
24	63.6	66.2	-	74.3	80.1	76.2	74.8	71.2	75.0	66.4	72.3	5.8
25	64.3	67.6	-	75.8	80.7	77.6	76.3	74.6	76.2	69.6	73.8	5.8
26	64.6	67.6	-	74.9	81.1	77.4	73.0	72.5	75.7	70.9	73.0	5.6
27	63.9	67.3	-	73.9	79.2	75.3	72.4	71.6	74.1	70.9	71.9	5.1
28	61.7	65.7	-	72.1	75.3	71.7	71.2	72.6	71.6	69.7	70.0	4.7
29	59.2	63.4	-	68.1	71.2	64.0	62.1	71.4	67.6	66.8	65.6	4.7
30	57.9	62.1	-	65.9	70.1	63.4	59.6	68.8	65.9	65.9	64.0	4.6
31	55.9	60.5	-	63.8	67.7	61.2	57.9	67.5	63.9	64.5	62.1	4.5
32	53.9	59.5	-	62.0	65.7	59.9	57.0	65.0	62.0	63.0	60.4	4.2
33	52.2	58.7	-	60.7	63.9	58.1	55.3	62.8	60.3	61.5	58.8	4.1
34	51.5	57.8	-	59.2	61.9	56.5	54.0	61.1	58.6	59.9	57.4	3.8
35	50.4	56.2	-	57.3	59.5	54.0	51.8	59.3	56.6	57.8	55.5	3.6
36	47.9	53.9	-	55.3	57.3	51.3	49.6	56.5	54.2	55.2	53.1	3.6
37	45.3	51.3	-	52.6	54.2	48.1	47.0	53.4	51.3	51.8	50.3	3.5
38	45.4	50.7	-	51.9	53.2	47.1	46.2	52.7	50.6	50.5	49.6	3.3
39	42.2	47.4	-	48.0	49.1	42.5	42.0	48.4	46.6	45.5	45.7	3.2
40	36.4	41.2	-	42.1	43.1	36.1	35.9	42.7	40.6	38.1	39.6	3.3
AL	68.6	72.7	-	78.3	83.0	79.0	77.2	78.6	78.5	78.5	76.8	4.7
OASPL	76.5	78.4	-	84.9	89.7	87.5	86.8	83.9	85.7	-	84.0	4.8
PNL	80.5	84.6	-	90.2	95.0	91.0	89.6	89.8	90.6	-	88.7	4.7
PNLT	81.5	85.6	-	91.4	96.4	92.7	91.0	91.1	92.0	-	90.0	4.9

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.4-5H.3

SIKORSKY S-76 HELICOPTER (SPIRIT)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 5H (HARD) - 150 M. NORTH JUNE 13,1983

GROUND IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	M2 90	135	180	225	M7 270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	--	--	48.2	--	--	--	51.6	--	50.2	5.5	49.9	2.4
15	--	--	47.3	--	--	--	48.7	--	48.1	8.7	48.0	1.0
16	--	--	47.7	--	--	--	48.7	--	48.2	13.6	48.2	0.7
17	--	--	54.5	--	--	--	56.5	--	55.6	25.4	55.5	1.4
18	--	--	55.1	--	--	--	58.0	--	56.8	30.6	56.6	2.1
19	--	--	52.3	--	--	--	53.2	--	52.8	30.3	52.7	0.6
20	--	--	55.6	--	--	--	58.1	--	57.0	37.9	56.9	1.8
21	--	--	51.3	--	--	--	52.3	--	51.8	35.7	51.8	0.7
22	--	--	53.7	--	--	--	55.6	--	54.8	41.4	54.6	1.3
23	--	--	54.5	--	--	--	56.5	--	55.6	44.7	55.5	1.4
24	--	--	54.8	--	--	--	56.5	--	55.7	47.1	55.6	1.2
25	--	--	53.2	--	--	--	55.1	--	54.3	47.7	54.1	1.3
26	--	--	52.4	--	--	--	53.5	--	53.0	48.2	52.9	0.8
27	--	--	51.4	--	--	--	53.8	--	52.8	49.6	52.6	1.7
28	--	--	48.5	--	--	--	53.0	--	51.3	49.4	50.7	3.2
29	--	--	45.5	--	--	--	50.4	--	48.6	47.8	47.9	3.5
30	--	--	43.6	--	--	--	48.8	--	46.9	46.9	46.2	3.7
31	--	--	42.2	--	--	--	46.0	--	44.5	45.1	44.1	2.7
32	--	--	41.5	--	--	--	43.9	--	42.9	43.9	42.7	1.7
33	--	--	39.9	--	--	--	41.1	--	40.5	41.7	40.5	0.8
34	--	--	37.9	--	--	--	38.6	--	38.3	39.6	38.2	0.5
35	--	--	37.2	--	--	--	38.0	--	37.6	38.8	37.6	0.6
36	--	--	38.4	--	--	--	38.6	--	38.5	39.5	38.5	0.1
37	--	--	37.0	--	--	--	37.1	--	37.1	37.6	37.1	0.1
38	--	--	36.5	--	--	--	36.0	--	36.3	36.2	36.2	0.4
39	--	--	35.0	--	--	--	34.4	--	34.7	33.6	34.7	0.4
40	--	--	34.9	--	--	--	33.9	--	34.4	31.9	34.4	0.7
AL	--	--	56.4	--	--	--	59.1	--	58.0	58.0	57.7	1.9
OASPL	--	--	64.8	--	--	--	66.9	--	66.0	--	65.8	1.5
PNL	--	--	68.7	--	--	--	70.5	--	69.7	--	69.6	1.3
PNLT	--	--	69.3	--	--	--	71.4	--	70.5	--	70.3	1.5

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.4-5H.2

SIKORSKY S-76 HELICOPTER (SPIRIT)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 5H (HARD) - 150 M. NORTH JUNE 13,1983

FLIGHT IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES)								AVERAGE LEVEL OVER 360 DEGREES			
	0 M4	45 MJ	90 M1	135 MF	180	225	270 M4	315 M5	ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	54.5	50.4	63.2	61.2	-	-	57.6	53.5	58.8	14.1	56.7	4.9
15	53.0	47.2	61.2	59.1	-	-	56.7	54.1	57.1	17.7	55.2	5.0
16	67.3	64.2	69.3	65.3	-	-	67.1	67.6	67.1	32.5	66.8	1.8
17	51.2	49.4	58.5	55.6	-	-	56.7	54.4	55.3	25.1	54.3	3.4
18	57.7	57.5	64.3	57.3	-	-	63.3	55.1	60.6	34.4	59.2	3.7
19	52.9	55.6	62.1	57.2	-	-	62.5	58.6	59.4	36.9	58.1	3.7
20	70.2	61.2	71.2	69.2	-	-	73.4	74.3	71.4	52.3	69.9	4.7
21	62.4	56.0	64.6	60.5	-	-	64.5	64.5	62.9	46.8	62.1	3.4
22	55.8	55.7	60.2	57.9	-	-	60.7	59.0	58.6	45.2	58.2	2.1
23	59.2	62.9	66.9	65.1	-	-	67.4	64.2	65.0	54.1	64.3	3.0
24	58.5	59.1	62.6	61.5	-	-	63.1	60.4	61.2	52.6	60.9	1.9
25	59.1	58.3	64.0	64.0	-	-	65.9	64.4	63.4	56.8	62.6	3.1
26	57.9	58.2	62.8	63.3	-	-	63.9	62.3	62.0	57.2	61.4	2.7
27	58.7	58.4	62.6	62.7	-	-	65.3	61.2	62.1	58.9	61.5	2.6
28	56.4	56.7	60.6	60.8	-	-	64.2	61.2	60.8	58.9	60.0	3.0
29	55.4	55.1	57.6	58.9	-	-	62.0	59.6	58.8	58.0	58.1	2.6
30	52.4	54.0	54.5	56.1	-	-	60.1	57.1	56.5	56.5	55.7	2.7
31	51.3	52.8	52.4	53.9	-	-	59.1	56.0	55.1	55.7	54.2	2.9
32	50.3	51.9	50.3	51.3	-	-	58.2	54.7	53.9	54.9	52.8	3.1
33	49.2	51.2	48.8	49.6	-	-	56.1	53.5	52.3	53.5	51.4	2.9
34	48.8	50.1	47.2	48.8	-	-	53.2	52.3	50.6	51.9	50.1	2.3
35	49.7	48.4	46.2	47.4	-	-	50.5	50.7	49.1	50.3	48.8	1.8
36	50.1	46.5	43.2	46.6	-	-	47.7	48.1	47.5	48.5	47.0	2.3
37	52.1	47.6	40.7	42.5	-	-	44.6	49.5	47.9	48.4	46.2	4.3
38	54.1	49.6	39.6	42.0	-	-	42.6	49.8	49.1	49.0	46.3	5.7
39	49.2	45.7	34.9	36.9	-	-	37.4	45.0	44.4	43.3	41.5	5.8
40	42.9	40.8	28.8	30.3	-	-	30.5	38.9	38.5	36.0	35.4	6.2
AL	64.9	64.6	67.1	67.4	-	-	70.5	68.2	67.6	67.6	67.1	2.2
OASPL	74.0	71.0	76.9	74.9	-	-	77.9	77.1	75.9	-	75.3	2.6
PNL	78.7	77.0	78.9	78.8	-	-	81.9	81.2	79.7	-	79.4	1.8
PNLT	80.8	77.9	80.2	80.6	-	-	83.5	83.3	81.4	-	81.0	2.1

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE D.1

STATIC OPERATIONS
DIRECT READ DATA
(ALL VALUES A-WEIGHTED LEQ, EXPRESSED IN DECIBLES)

SIKORSKY S-76

6-13-83

SITE 4H

HIGE		FLT.IDLE		GRN.IDLE	
L-0	54.40	M-0A	47.80	M-0B	49.60
L-315	62.70	M-315A	54.20	M-315B	NA
L-270	59.00	M-270A	52.20	M-270B	NA
L-225	63.20	M-225A	53.30	M-225B	NA
L-180	66.20	M-180A	53.00	M-180B	39.40
L-135	64.90	M-135A	NA	M-135B	NA
L-90	61.30	M-90A	NA	M-90B	NA
L-45	56.30	M-45A	50.10	M-45B	NA

SITE 2

HIGE		FLT.IDLE		GND.IDLE	
L-0	63.90	M-0A	57.10	M-0B	54.80
L-315	72.10	M-315A	61.50	M-315B	NA
L-270	69.60	M-270A	60.30	M-270B	NA
L-225	73.20	M-225A	62.80	M-225B	NA
L-180	76.10	M-180A	61.40	M-180B	45.20
L-135	77.00	M-135A	NA	M-135B	NA
L-90	71.80	M-90A	NA	M-90B	NA
L-45	67.90	M-45A	59.70	M-45B	NA

SITE 5H

HIGE		FLT.IDLE		GND.IDLE	
L-0	68.40	M-0A	64.80	M-0B	NA
L-315	78.00	M-315A	68.20	M-315B	NA
L-270	78.00	M-270A	70.90	M-270B	59.80
L-225	79.80	M-225A	NA	M-225B	NA
L-180	82.50	M-180A	NA	M-180B	NA
L-135	79.60	M-135A	66.80	M-135B	NA
L-90	75.40	M-90A	66.90	M-90B	57.30
L-45	71.80	M-45A	64.40	M-45B	NA

APPENDIX D

Direct Read Acoustical Data for Static Operations

This appendix contains time averaged, A-weighted sound level data (Leq values) obtained using direct read Precision Integrating Sound Level meters. Data are presented for microphone locations 5H, 2, and 4 (see Figure 3.3).

A description of the measurement systems is provided in Section 5.6.2, and a figure of the typical PISLM system is shown in Figure 5.4. Data are shown in Table D-1, depicting the equivalent sound levels for eight different source emission angles. In each case the angle is indexed to the specific measurement site. A figure showing the emission angle convention is included in the text (Figure 6.1). In each case, the Leq (or time averaged AL) represents an average over a sample period of approximately 60 seconds.

Quantities appearing in this appendix include:

HIGE	Hover-in-ground-effect, skid height 5 feet above ground level
HOGE	Hover-out-of-ground-effect, skid height 30 feet above ground level
Flight Idle	Skids on ground
Ground Idle	Skids on ground

TABLE E.1

COCKPIT PHOTO DATA

HELICOPTER Sikorsky

TEST DATE 6/13/83

EVENT NO.	EVENT TYPE	TIME OF PHOTO	HEADING (DEGREES)	ALTIMETER (AGL) FT. (METERS)	IAS (KTS)	ROTOR SPEED (RPM OR %)	TORQUE (%)
A1	500' LFO 1.0 VNE	6:06	120	–	140	100	95
A2	500' LFO 1.0 VNE	6:08	300	–	142	100	95
A3	500' LFO 1.0 VNE	6:10	120	–	145	100	95
A4	500' LFO 1.0 VNE	6:15	300	–	142	100	95
A5	500' LFO 1.0 VNE	6:17	120	–	145	100	92
A5	500' LFO 1.0 VNE	6:17	120	750	145	100	90
A6	500' LFO 1.0 VNE	6:20	300	–	145	100	95
B7	500' LFO 0.9 VNE	6:22	120	700	120	100	65
B8	500' LFO 0.9 VNE	6:25	300	–	–	100	70
B9	500' LFO 0.9 VNE	6:27	120	760	125	100	65
B10	500' LFO 0.9 VNE	6:29	300	–	130	100	68
B11	500' LFO 0.9 VNE	6:32	120	700	130	100	76
B12	500' LFO 0.9 VNE	6:34	300	–	–	100	70
B13	500' LFO 0.9 VNE	6:36	120	800	130	100	70
C14	500' LFO 0.8 VNE	6:39	300	–	–	100	55
C15	500' LFO 0.8 VNE	6:45	120	740	115	100	48
C16	500' LFO 0.8 VNE	6:48	300	–	–	100	52
C17	500' LFO 0.8 VNE	6:58	120	700	115	100	64
C18	500' LFO 0.8 VNE	7:00	300	–	–	100	52
D19	500' LFO 0.7 VNE	7:06	120	700	100	100	45
D20	500' LFO 0.7 VNE	7:08	300	–	–	100	48
D21	500' LFO 0.7 VNE	7:11	120	700	100	100	45
D22	500' LFO 0.7 VNE	7:13	300	–	–	100	45
D23	500' LFO 0.7 VNE	7:16	120	700	100	100	45
E24	1000' LFO 1.0 VNE	7:27	120	1270	150	100	95
E25	1000' LFO 1.0 VNE	7:29	305	–	140	100	90
E26	1000' LFO 1.0 VNE	7:32	120	1250	145	100	90
E27	1000' LFO 1.0 VNE	7:35	305	–	145	100	90
E28	1000' LFO 1.0 VNE	7:37	120	1250	145	100	90

APPENDIX E

Cockpit Instrument Photo Data

During each event of the June 1983 Helicopter Noise Measurement program cockpit photos were taken. The slides were projected onto a screen (considerably enlarged) making it possible to read the instruments with reasonable accuracy. The photos were supposed to be taken when the aircraft was directly over the centerline-center microphone site. Although this was not achieved in each case the cockpit photos reflect the helicopter "stabilized" configuration during the test event. One important caution is necessary in interpreting the photographic information; the snapshot freezes instrument readings at one moment of time whereas most readings are constantly changing by a small amount as the pilot "hunts" for the reference condition. Thus fluctuations above or below reference conditions are to be anticipated. The instrument readings are most useful in terms of verifying the region of operation for different parameters. The data acquisition is discussed in Section 5.3

Each table within this appendix provides the following information:

Event No.	This event number along with the test date provides a cross reference to other data.
Event Type	This specifies the event.
Time of Photo	The time of the range control synchronized clock consistent with acoustical and tracking time bases.
Heading	The compass magnetic heading which fluctuates around the target heading.
Altimeter	Specifies the barometric altimeter reading, one of the more stable indicators.
IAS	Indicated airspeed, a fairly stable indicator.
Rotor Speed	Main Rotor speed in RPM or percent, a very stable indicator.
Torque	The torque on the main rotor shaft, a fairly stable value.

TABLE E.3

COCKPIT PHOTO DATA

HELICOPTER Sikorsky (Cont.) TEST DATE 6/13/83

EVENT NO.	EVENT TYPE	TIME OF PHOTO	HEADING (DEGREES)	ALTIMETER (AGL) FT. (METERS)	IAS (KTS)	ROTOR SPEED (RPM OR %)	TORQUE (%)
K62	APPROACH	10:58	90	620	75	100	15
K63	APPROACH	11:01	95	760	72	104	10
K64	APPROACH	11:04	95	1000	75	104	15
K65	APPROACH	11:07	95	920	74	102	18
K66	APPROACH	11:10	95	760	74	102	10
L300	HIGE	11:48	305	240	–	100	85
L345	HIGE	11:49	350	240	–	100	85
L030	HIGE	11:51	040	240	–	100	85
L075	HIGE	11:53	080	240	–	100	86
L120	HIGE	11:55	130	240	–	100	88
L165	HIGE	11:56	175	240	–	100	85
L210	HIGE	11:58	225	240	–	100	85
L255	HIGE	12:02	260	240	–	100	20
M300A	FLT IDLE	12:04	255	240	–	57	08
M300B	GND IDLE	12:08	310	240	–	100	20
M345A	FLT IDLE	12:10	005	240	–	100	20
M030A	FLT IDLE	12:11	075	–	–	100	20
M075A	FLT IDLE	12:14	115	260	–	100	20
M120A	FLT IDLE	12:15	115	250	–	53	6
M120B	GND IDLE	12:17	170	250	–	100	20
M255A	FLT IDLE	12:23	305	280	–	100	90
067	TAKEOFF	12:42	295	280	30	100	90
069	TAKEOFF	12:45	110	340	30	100	26
070	TAKEOFF	12:49	110	300	30	100	40
071	TAKEOFF	12:52	295	290	30	100	90
072	TAKEOFF	12:56	120	320	30	100	38
073	TAKEOFF	12:58	300	280	50	100	85
074	TAKEOFF	13:00	120	300	30	100	45
075	TAKEOFF	13:03	300	280	45	100	85
076	TAKEOFF	13:06	120	320	40	100	20

TABLE E.2

COCKPIT PHOTO DATA

HELICOPTER Sikorsky (Cont.) TEST DATE 6/13/83

EVENT NO.	EVENT TYPE	TIME OF PHOTO	HEADING (DEGREES)	ALTIMETER (AGL) FT. (METERS)	IAS (KTS)	ROTOR SPEED (RPM OR %)	TORQUE (%)
F29	TAKEOFF (ICAO)	7:46	300	–	78	100	85
F30	TAKEOFF (ICAO)	7:48	305	–	–	100	80
F31	TAKEOFF (ICAO)	7:51	300	–	–	100	82
F32	TAKEOFF (ICAO)	7:54	300	–	–	100	75
F33	TAKEOFF (ICAO)	7:57	300	–	–	100	80
F34	TAKEOFF (ICAO)	8:00	300	–	78	100	80
F35	TAKEOFF (ICAO)	8:47	300	–	80	100	80
F36	TAKEOFF (ICAO)	8:07	300	–	78	100	75
G37	APPROACH	8:59	100	620	76	100	30
G38	APPROACH	9:02	95	650	80	100	36
G40	APPROACH	9:12	95	620	75	100	30
G41	APPROACH	9:16	100	580	78	100	26
G42	APPROACH	9:20	100	620	79	100	30
G43	APPROACH	9:24	100	620	77	100	35
H44	TAKEOFF	9:41	275	500	65	100	95
H45	TAKEOFF	9:44	275	600	70	100	92
H46	TAKEOFF	9:47	275	620	75	100	92
H47	TAKEOFF	9:50	275	500	55	100	95
H48	TAKEOFF	9:53	275	–	–	100	90
H49	TAKEOFF	9:56	275	–	60	100	95
I50	APPROACH	10:02	90	640	75	100	25
I51	APPROACH	10:05	90	550	72	100	18
I52	APPROACH	10:09	90	700	73	100	15
I54	APPROACH	10:19	90	640	75	100	24
I55	APPROACH	10:24	90	600	75	100	24
J56	TAKEOFF	10:30	275	450	–	100	85
J57	TAKEOFF	10:37	280	440	83	100	90
J58	TAKEOFF	10:42	275	280	75	100	65
J59	TAKEOFF	10:45	280	310	72	100	75
J60	TAKEOFF	10:50	280	340	70	100	83

TABLE F.1

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT.FLYOVER(1.0*VNE)/TARGET IAS=145 KTS

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	REG. C/D ANGLE
A1	458.2	463.6	454.8	444.4	452.2	458.8	670	42.8	670.3	42.7	-2.1	1.7	-.2	-.2
A2	496.8	493.4	492.4	502.5	488.9	484.4	696.1	45	696.5	45	1.1	-2	-.4	-.3
A3	501.7	500.4	492.5	500.4	485.1	483	696.1	45	697	45	0	-1.9	-.9	-.8
A4	431.4	430.8	435.2	NA	437.5	436.9	656.9	41.5	656.6	NA	NA	NA	.4	.4
A5	477	478.7	466	468.1	457.2	458.8	677.7	43.4	678.6	43.4	-1.1	-1	-1.1	-.9
A6	454.9	452.9	465.5	464.5	474	471.9	677.3	43.4	676.4	43.5	1.4	.9	1.1	1
AVERAGE	470	470	467.7	476	465.8	465.6	679	43.5	679.2	43.9				
STD. DEV	27	26.1	22.1	25	20.2	18	15.2	1.3	15.6	1				

TABLE F.2

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT.FLYOVER(0.9*VNE)/TARGET IAS=130 KTS

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	REG. C/D ANGLE
B7	457.8	460	438.5	443.6	423.2	425.2	659.1	41.7	660.7	41.6	-1.8	-2	-1.9	-1.7
B8	456.7	454.1	460.9	464.5	464.3	461.2	674.2	43.1	673.8	43.2	1.2	-.3	.4	.4
B9	508.6	510.5	491.6	496.4	478.1	479.7	695.5	45	697.1	44.9	-1.5	-1.8	-1.7	-1.5
B10	496.8	496.2	497.2	498.4	497.6	496.8	699.5	45.3	699.5	45.3	.3	-.1	0	0
B11	466.7	470.7	446.9	450.9	427.1	NA	664.7	42.2	663.4	NA	-2.2	NA	NA	-2.2
B12	492.5	492.8	485.7	488.5	480.3	480.4	691.3	44.6	691.9	44.6	-.4	-.8	-.6	-.5
B13	544.5	544.9	532.1	537.6	522.2	522.2	724.7	47.2	725.8	47.2	-.8	-1.7	-1.2	-1.1
AVERAGE	489.1	489.9	479	482.8	470.4	477.6	687	44.2	687.5	44.5				
STD. DEV	31.8	31.7	32.5	32.5	35.9	183	22.8	1.9	23.1	1.9				

APPENDIX F

Photo-Altitude and Flight Path Trajectory Data

This appendix contains the results of the photo-altitude and flight path trajectory analysis.

The helicopter altitude over a given microphone was determined by a photographic technique which involves photographing an aircraft during a flyover event and proportionally scaling the resulting image with the known dimensions of the aircraft. The data acquisition is described in detail in Section 5.2. The detailed data reduction procedures is set out in Section 6.2.1; the analysis of these data is discussed in Section 8.2

Each table within this appendix provides the following information:

Event No.	the test run number
Est. Alt.	estimated altitude above microphone site
P-Alt.	altitude above photo site, determined by photographic technique
Est. CPA	estimated closest point of approach to microphone site
Est. ANG	Helicopter elevation with respect to the ground as viewed from a sideline site as the helicopter passes through a plane perpendicular to the flight track and coincident with the observer location.
ANG 5-1	flight path slope, expressed in degrees, between P-Alt site 5 and P-Alt site 1.
ANG 1-4	flight path slope, expressed in degrees, between P-Alt Site 1 and P-Alt Site 4.
ANG 5-4	flight path slope, expressed in degrees, between P-Alt Site 5 and P-Alt Site 4.
Reg C/D Angle	flight path slope, expressed in degress, of regression line through P-Alt data points.

TABLE F.5

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 1000 FT.FLYOVER(1.0*VNE)/TARGET IAS=145 KTS

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	REG. C/D ANGLE
E24	1070	1075.9	1060	1052.1	1052	1058.9	1168.6	65.1	1169.8	65.1	-2.7	.8	-.9	-.8
E25	1055.2	1060.4	1054.7	1043.2	1054.4	1060.9	1163.8	65	1163.9	65	-1.9	2.1	0	0
E26	1069.9	1072	1061.5	1061.2	1054.7	1057	1169.9	65.1	1170.9	65.1	-1.2	-.4	-.8	-.7
E27	973.5	972.6	976.6	977	979.1	978.1	1093.5	63.3	1093.2	63.3	.5	.1	.3	.3
E28	1061.5	1068.1	1036.1	1034.5	1015.9	1023.2	1147	64.6	1149.9	64.6	-3.8	-1.2	-2.5	-2.3
AVERAGE	1046	1049.8	1037.8	1033.6	1031.2	1035.6	1148.6	64.6	1149.5	64.6				
STD. DEV	41	43.5	35.7	33.2	33.4	35.7	32.1	.8	32.6	.8				

TABLE F.6

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: ICAO TAKEOFF/TARGET IAS=74 KTS

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	REG. C/D ANGLE
F29	322.9	307.8	427.6	406.3	511.1	496.5	651.8	41	643.1	41.5	11.3	10.4	10.9	9.7
F30	333.3	318	438.2	417.3	521.9	507.1	658.9	41.7	650	42.2	11.4	10.3	10.9	9.7
F31	317.4	298.3	449.7	423	555.1	536.6	666.5	42.4	655.2	43	14.2	13	13.6	12.3
F32	342.4	330.4	428.6	410.3	497.3	485.7	652.5	41.1	645.3	41.5	9.2	8.7	9	8
F33	287.7	274.2	375	359.4	444.6	431.3	618.6	37.3	611.9	37.8	9.8	8.3	9.1	8.1
F34	268.8	250.8	389.7	366.4	486.1	468.6	627.6	38.4	618.1	39	13.2	11.7	12.5	11.2
F35	232.9	216.4	329.1	315.6	405.8	389.1	591.9	33.8	585.2	34.4	11.4	8.5	10	8.9
F36	256.4	239.3	360.1	343.9	442.8	425.6	609.7	36.2	601.9	36.8	12	9.4	10.7	9.6
AVERAGE	295.2	279.4	399.7	380.3	483.1	467.6	634.7	39	626.4	39.5				
STD. DEV	39.8	40.8	42.8	39.5	48.9	48.9	26.7	3.1	25.6	3				

TABLE F.3

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT.FLYOVER(0.8*VNE)/TARGET IAS=115 KTS

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	C/D ANGLE
C14	495.8	493.6	503.4	504.5	509.5	507	703.9	45.7	703.2	45.7	1.3	.3	.8	.7
C15	466.9	467	466.4	466.3	466	466.2	677.9	43.5	678	43.5	0	0	0	0
C16	508.3	509	503.9	504.5	500.3	501.1	704.2	45.7	704.6	45.7	-.4	-.3	-.4	-.3
C17	479.5	481.5	472.3	471.6	466.5	468.7	682	43.8	682.6	43.8	-1.1	-.2	-.6	-.6
C18	488.4	487.9	482.2	486.6	477.3	476.4	688.9	44.4	689.5	44.4	-.1	-1.1	-.6	-.5
AVERAGE	487.8	487.8	485.6	486.7	483.9	483.9	691.4	44.6	691.6	44.6				
STD. DEV	15.7	15.5	17.4	17.9	19.9	18.9	12.2	1	12	1				

TABLE F.4

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 500 FT.FLYOVER(0.7*VNE)/TARGET IAS=100 KTS

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	C/D ANGLE
D19	458	456.1	461	463.7	463.5	461.2	674.2	43.1	674	43.2	.9	-.2	.3	.3
D20	457	456.8	457.4	457.6	457.8	457.6	671.8	42.9	671.8	42.9	.1	0	0	0
D21	476.2	477.6	471.5	470.7	467.7	469.3	681.4	43.8	681.8	43.8	-.7	-.1	-.4	-.3
D22	455	455.4	448	450.9	442.3	442.5	665.4	42.3	666	42.3	-.4	-.9	-.7	-.6
D23	458.3	459.7	449.3	450.9	442.2	443.6	666.3	42.4	667.1	42.4	-.9	-.8	-.8	-.7
AVERAGE	460.9	461.1	457.4	458.8	454.7	454.8	671.8	42.9	672.1	42.9				
STD. DEV	8.6	9.4	9.5	8.5	11.9	11.6	6.5	.6	6.3	.6				

TABLE F.9

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=74 KTS

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	REG. C/D ANGLE
I50	291.8	284.6	361.6	341	417.3	411.2	610.6	36.3	605.4	36.7	6.5	8.1	7.3	6.5
I51	310.8	298.3	364.2	364.2	406.9	393.4	612.2	36.5	608.1	36.8	7.6	3.4	5.5	5
I52	310.7	306.4	360.6	343.9	400.3	397	610	36.2	606.2	36.5	4.4	6.2	5.3	4.6
I53	292.6	283.4	357.1	343.9	408.6	399.7	608	36	603.1	36.3	7	6.5	6.7	6
I54	314.8	305.1	379.8	367.5	431.6	422.1	621.6	37.7	616.5	38	7.2	6.3	6.8	6
I55	300.8	290.7	362.2	352.7	411.2	401	611	36.4	606.3	36.7	7.2	5.6	6.4	5.7
AVERAGE	303.6	294.8	364.3	352.2	412.7	404.1	612.2	36.5	607.6	36.8				
STD. DEV	10	10	8	11.3	10.8	10.7	4.8	.6	4.6	.6				

TABLE F.10

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: TAKEOFF W/TURN/TARGET IAS=74 KTS

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	REG. C/D ANGLE
J56	NA	NA	NA	347.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
J57	325.9	306.4	421.8	402.3	517.7	NA	648.1	40.6	653.9	NA	NA	NA	NA	NA
J58	277.2	258.5	369.4	350.7	461.6	NA	615.3	36.9	620.5	NA	11	NA	NA	11
J59	273.3	254.6	365.5	346.8	457.7	NA	612.9	36.6	618.1	NA	10.6	NA	NA	10.6
J60	236.2	216.4	333.8	314	431.4	NA	594.6	34.2	599.7	NA	11.2	NA	NA	11.2
AVERAGE	278.2	259	372.7	352.3	467.1		617.7	37.1	623.1					
STD. DEV	36.8	36.9	36.4	31.7	36.3		22.3	2.6	22.6					

TABLE F.7

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 3 DEGREE APPROACH/TARGET IAS=74 KTS

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
	EST.		EST.		EST.		EST.	ELEV	EST.	ELEV	ANG	ANG	ANG	C/D
EVENT NO	ALT.	P-ALT.	ALT.	P-ALT.	ALT.	P-ALT.	CPA	ANG	CPA	ANG	5-1	1-4	5-4	ANGLE
G37	350.2	349.1	372.5	363.1	390.3	389.9	617.1	37.1	615.4	37.3	1.6	3.1	2.4	2.1
G38	336	333.6	366.6	355.8	391	389.3	613.6	36.7	611.2	36.9	2.6	3.9	3.2	2.8
G39	334.5	328.8	372.4	365.3	402.6	397	617	37.1	614.1	37.3	4.2	3.7	4	3.5
G40	369.8	366.1	399.1	392	422.4	419	633.5	39	631.2	39.2	3	3.1	3.1	2.7
G41	327.9	327.2	340.5	335.4	350.5	350.2	598.3	34.7	597.4	34.8	1	1.7	1.3	1.2
G42	360.7	355.5	397	389.6	426	421	632.2	38.9	629.3	39.1	4	3.7	3.8	3.4
G43	344.3	354.6	463.8	377.6	559.1	576.9	676.1	43.3	665.7	43.9	2.7	22.1	12.7	11.1
AVERAGE	346.2	345	387.4	368.4	420.3	420.5	626.8	38.1	623.5	38.4				
STD. DEV	15.1	15.1	39	19.9	66.1	72.9	24.8	2.7	21.8	2.9				

TABLE F.8

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: TAKEOFF/CATAGORY B

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
	EST.		EST.		EST.		EST.	ELEV	EST.	ELEV	ANG	ANG	ANG	C/D
EVENT NO	ALT.	P-ALT.	ALT.	P-ALT.	ALT.	P-ALT.	CPA	ANG	CPA	ANG	5-1	1-4	5-4	ANGLE
H44	346.6	340.3	389.7	381.1	424.1	418	627.6	38.4	624.2	38.6	4.7	4.3	4.5	4
H45	391.5	382.6	450.6	439.6	497.8	489	667.2	42.5	662.1	42.8	6.6	5.7	6.2	5.5
H46	361.3	362.2	405	379.9	439.8	442.7	637.2	39.5	633.7	39.7	2.1	7.3	4.7	4.1
H47	428.9	420.7	500	480.9	556.6	549.3	701.4	45.5	695	45.8	7	7.9	7.4	6.6
H48	369	368.1	443.5	406.3	502.9	504.8	662.4	42	656	42.4	4.4	11.3	7.9	6.9
H49	415.4	398.4	476.4	482.7	525.1	506.2	684.9	44.1	679.5	44.4	9.7	2.7	6.3	5.7
AVERAGE	385.5	378.7	444.2	428.4	491	485	663.5	42	658.4	42.3				
STD. DEV	32.2	28.4	41.7	46.7	50.5	47.5	27.9	2.7	26.8	2.7				

TABLE F.11

HELICOPTER: SIKORSKY S-76

TEST DATE: 6-13-83

OPERATION: 9 DEGREE APPROACH/TARGET IAS=74 KTS

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	REG. C/D ANGLE
K61	297.2	282.2	393.6	376.5	470.4	455.6	630	38.7	622.4	39.2	10.9	9.1	10	9
K62	311.4	297	390.1	381.1	452.8	438	627.9	38.4	621.7	38.8	9.7	6.6	8.2	7.3
K63	294.5	278.7	404.7	382.3	492.6	477.3	637.1	39.4	628.2	40	11.9	10.9	11.4	10.2
K64	298.4	281	410.8	390.8	500.3	483.1	640.9	39.9	631.8	40.4	12.6	10.6	11.6	10.4
K65	318.3	299.7	433.3	NA	501.7	483.1	655.6	41.4	646	NA	NA	NA	10.6	10.6
K66	305.9	290.7	407.9	388.3	489.3	474.5	639.1	39.7	630.9	40.2	11.2	9.9	10.6	9.5
AVERAGE	304.3	288.2	406.7	383.8	484.5	468.6	638.4	39.6	630.2	39.7				
STD. DEV	9.3	8.9	15.4	5.7	19.2	18.1	9.8	1.1	8.8	.7				

APPENDIX G

NWS Upper Air Meteorological Data

This appendix presents a summary of meteorological data gleaned from National Weather Service radiosonde (rawinsonde) weather balloon ascensions conducted at Sterling, VA. The data collection is further described in Section 5.4. Tables are identified by launch date and launch time. Within each table the following data are provided:

Time	expressed first in Eastern Standard, then in Eastern Daylight Time
Surface Height	height of launch point with respect to sea level
Height	height above ground level, expressed in feet
Pressure	expressed in millibars
Temperature	expressed in degrees centigrade
Relative Humidity	expressed as a percent
Wind Direction	the direction from which the wind is blowing (in degrees)
Wind Speed	expressed in knots

TABLE G.1

DATE: 6 / 13 / 83

TIME: 430 EST FLIGHT # 1 5:30 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1009.5	15.6	96	0	0
100	1005.9	17.4	98	-999	-999
200	1002.4	18.4	83	-999	-999
300	998.8	19.6	71	-999	-999
400	995.2	21.2	64	16	7
500	991.8	21.6	60	335	8
600	988.3	22.1	57	312	14
700	984.9	23.1	52	313	15
800	981.4	23.5	48	331	11
900	978.0	23.8	44	344	9
1000	974.6	24.1	41	354	8
1100	971.2	24.2	39	354	8
1200	967.9	24.2	38	356	7
1300	964.5	24.2	37	358	7
1400	961.2	24.2	36	359	6
1500	957.8	24.2	36	359	7
1600	954.5	24.2	35	3	6
1700	951.2	24.0	37	9	5
1800	947.9	23.9	39	3	6
1900	944.6	23.7	40	7	6
2000	941.3	23.6	42	13	6
2100	938.0	23.4	43	14	6
2200	934.7	23.3	45	20	6
2300	931.4	23.0	45	29	7
2400	928.2	22.7	45	27	7
2500	924.9	22.4	45	37	8
2600	921.7	22.0	43	33	9
2700	918.5	21.8	41	36	8
2800	915.3	21.6	41	42	8
2900	912.1	21.4	40	40	9
3000	909.0	21.2	39	45	9

TABLE G.2

DATE: 6 / 13 / 83

TIME: 459 EST FLIGHT # 2 5:59 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1009.5	15.6	95	0	0
100	1005.9	17.2	98	-999	-999
200	1002.4	19.6	-10	-999	-999
300	998.8	21.5	-36	350	6
400	995.3	22.4	71	341	7
500	991.9	22.7	68	330	9
600	988.4	23.1	65	311	14
700	985.0	24.0	61	316	12
800	981.6	24.5	56	329	8
900	978.2	25.0	52	331	9
1000	974.8	25.2	52	335	9
1100	971.4	25.0	52	351	6
1200	968.1	24.8	52	6	5
1300	964.7	24.6	52	355	5
1400	961.3	24.3	52	4	4
1500	958.0	24.1	52	348	5
1600	954.7	23.9	52	350	5
1700	951.4	23.7	53	352	5
1800	948.1	23.5	53	356	5
1900	944.8	23.3	53	6	5
2000	941.5	23.1	53	11	6
2100	938.2	22.9	54	19	6
2200	934.9	22.7	54	25	7
2300	931.7	22.4	54	36	7
2400	928.4	22.2	53	43	7
2500	925.2	22.0	52	40	8
2600	922.0	21.8	52	47	7
2700	918.8	21.5	52	46	8
2800	915.6	21.3	52	45	9
2900	912.4	21.1	52	47	9
3000	909.2	20.9	52	43	9

TABLE G.3

DATE: 6 / 13 / 83

TIME: 529 EST FLIGHT # 3 6:29 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1009.8	16.1	95	270	1
100	1006.2	17.5	99	-999	-999
200	1002.7	19.7	90	-999	-999
300	999.1	21.5	80	342	6
400	995.7	22.3	71	325	8
500	992.2	22.9	68	320	11
600	988.7	23.5	64	312	14
700	985.3	24.2	59	312	13
800	981.9	24.9	56	317	12
900	978.5	25.0	53	319	13
1000	975.1	25.2	50	328	10
1100	971.7	25.1	50	338	8
1200	968.4	25.0	50	342	7
1300	965.0	24.9	50	355	5
1400	961.7	24.7	50	342	6
1500	958.3	24.4	49	351	6
1600	955.0	24.2	49	354	5
1700	951.7	24.0	50	347	5
1800	948.4	23.8	51	355	5
1900	945.1	23.6	51	14	5
2000	941.9	23.3	52	21	5
2100	938.6	23.1	53	18	6
2200	935.3	22.9	54	22	7
2300	932.0	22.6	54	28	7
2400	928.7	22.3	54	35	7
2500	925.5	21.9	53	44	7
2600	922.2	21.6	53	44	8
2700	919.0	21.4	53	46	8
2800	915.8	21.3	53	47	8
2900	912.6	21.1	53	47	9
3000	909.4	21.0	53	40	10

TABLE G.4

DATE: 6 / 13 / 83

TIME: 600 EST FLIGHT # 4 7:00 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1010.2	17.2	95	0	0
100	1006.6	18.3	90	292	22
200	1003.1	19.4	84	-999	-999
300	999.5	20.4	79	-999	-999
400	996.0	21.3	76	62	15
500	992.6	22.1	72	22	10
600	989.1	23.0	68	327	14
700	985.7	23.5	66	313	17
800	982.3	24.0	63	307	12
900	978.9	24.5	61	310	12
1000	975.5	24.9	58	322	10
1100	972.1	25.0	57	356	6
1200	968.7	24.9	56	20	4
1300	965.4	24.8	55	356	6
1400	962.0	24.7	55	328	6
1500	958.6	24.6	54	342	5
1600	955.3	24.4	55	359	4
1700	952.0	24.1	56	27	4
1800	948.7	23.9	56	73	3
1900	945.4	23.6	57	65	2
2000	942.1	23.4	57	357	5
2100	938.9	23.2	56	354	6
2200	935.6	23.0	56	5	5
2300	932.3	22.7	56	21	8
2400	929.1	22.5	57	19	5
2500	925.8	22.3	57	52	6
2600	922.6	22.0	57	53	7
2700	919.4	21.8	57	38	6
2800	916.2	21.5	57	52	7
2900	913.0	21.3	56	57	6
3000	909.8	21.0	56	54	7

TABLE G.5

DATE: 6 / 13 / 83

TIME: 659 EST FLIGHT # 5 7:59 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1010.4	21.1	82	0	0
100	1006.9	21.2	76	-999	-999
200	1003.4	21.8	72	303	12
300	999.8	22.4	68	315	10
400	996.4	23.0	65	318	12
500	992.9	23.6	62	317	15
600	989.5	24.3	59	318	16
700	986.0	24.9	56	325	14
800	982.6	25.4	54	340	11
900	979.2	25.4	51	346	10
1000	975.8	25.3	50	342	12
1100	972.5	25.2	50	343	12
1200	969.1	25.1	50	344	11
1300	965.8	24.9	50	343	11
1400	962.4	24.8	50	339	10
1500	959.1	24.6	50	342	9
1600	955.7	24.5	50	346	8
1700	952.4	24.2	50	344	7
1800	949.1	24.0	51	342	6
1900	945.9	23.7	51	343	7
2000	942.6	23.5	52	352	7
2100	939.3	23.2	52	355	8
2200	936.0	23.0	52	12	7
2300	932.7	22.7	53	22	6
2400	929.5	22.5	53	31	6
2500	926.2	22.3	53	34	6
2600	923.0	22.0	54	37	7
2700	919.8	21.8	54	50	8
2800	916.6	21.6	54	52	8
2900	913.4	21.4	54	54	7
3000	910.1	21.2	55	52	8

TABLE G.6

DATE: 6 / 13 / 83

TIME: 758 EST FLIGHT # 6 8:58 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1010.8	24.1	71	330	3
100	1007.3	23.3	70	-999	-999
200	1003.8	23.1	72	-999	-999
300	1000.3	23.0	74	-999	-999
400	996.8	22.8	73	327	6
500	993.4	22.5	71	355	5
600	989.9	22.3	70	334	9
700	986.4	23.4	64	326	14
800	983.0	24.4	59	340	14
900	979.6	25.2	55	342	13
1000	976.2	25.3	55	345	13
1100	972.9	25.3	55	354	11
1200	969.5	25.2	54	360	9
1300	966.2	25.2	53	9	8
1400	962.8	25.2	52	18	6
1500	959.5	25.1	51	14	5
1600	956.2	25.0	50	5	6
1700	952.8	24.8	51	13	6
1800	949.5	24.6	51	24	6
1900	946.2	24.4	52	25	7
2000	942.9	24.2	51	28	7
2100	939.7	23.9	50	26	7
2200	936.4	23.6	49	21	8
2300	933.1	23.4	49	25	8
2400	929.9	23.1	48	39	7
2500	926.7	22.8	49	47	7
2600	923.5	22.6	50	38	7
2700	920.2	22.3	51	36	7
2800	917.0	22.1	52	48	7
2900	913.8	21.8	52	56	7
3000	910.6	21.5	53	58	6

TABLE G.7

DATE: 6 / 13 / 83

TIME: 900 EST FLIGHT # 7 10:00 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1011.1	26.4	66	360	5
100	1007.6	25.6	65	-999	-999
200	1004.2	25.1	65	-999	-999
300	1000.6	24.9	67	-999	-999
400	997.2	24.7	68	336	6
500	993.8	24.5	68	339	6
600	990.4	24.2	69	344	7
700	986.9	24.0	70	345	7
800	983.5	23.8	71	341	7
900	980.1	23.5	71	340	8
1000	976.7	23.3	71	347	9
1100	973.2	23.4	64	357	11
1200	969.9	23.7	61	359	11
1300	966.5	23.9	59	8	9
1400	963.2	24.1	56	11	8
1500	959.8	24.4	53	15	7
1600	956.5	24.4	51	19	7
1700	953.2	24.2	51	19	6
1800	949.9	23.9	51	21	6
1900	946.6	23.7	52	21	6
2000	943.3	23.5	52	24	6
2100	939.9	23.2	52	27	7
2200	936.7	23.0	52	35	7
2300	933.4	22.8	53	43	7
2400	930.2	22.5	53	38	8
2500	927.0	22.3	53	41	8
2600	923.7	22.0	54	41	8
2700	920.5	21.8	54	41	9
2800	917.3	21.5	55	43	8
2900	914.1	21.3	55	41	7
3000	910.8	21.0	56	42	7

TABLE G.8

DATE: 6 / 13 / 83

TIME: 1000 EST FLIGHT # 8 11:00 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1011.1	28.1	61	340	4
100	1007.6	27.8	60	296	14
200	1004.2	27.5	59	-999	-999
300	1000.7	27.2	58	-999	-999
400	997.3	26.8	59	76	12
500	993.9	26.4	60	64	7
600	990.5	26.1	60	24	5
700	987.1	25.7	61	346	5
800	983.6	25.3	62	346	6
900	980.2	25.0	63	358	6
1000	976.8	24.6	64	10	6
1100	973.4	24.5	60	5	8
1200	970.1	24.5	58	357	9
1300	966.7	24.5	56	6	10
1400	963.4	24.5	54	16	9
1500	960.0	24.5	52	24	9
1600	956.7	24.5	49	22	8
1700	953.4	24.3	49	21	8
1800	950.1	24.0	49	20	8
1900	946.8	23.8	49	28	7
2000	943.5	23.5	50	23	7
2100	940.2	23.2	50	22	7
2200	936.9	23.0	50	19	6
2300	933.7	22.7	50	21	6
2400	930.5	22.5	51	23	6
2500	927.3	22.3	51	17	6
2600	924.1	22.1	52	23	5
2700	920.9	21.8	52	29	6
2800	917.7	21.6	52	33	5
2900	914.5	21.4	53	31	6
3000	911.3	21.1	53	41	6

APPENDIX H

NWS - IAD Surface Meteorological Data

This appendix presents a summary of meteorological data gleaned from measurements conducted by the National Weather Service Station at Dulles. Readings were noted evey 15 minutes during the test. The data acquisition is described in Section 5.5.

Within each table the following data are provided:

Time(EDT)	time the measurement was taken, expressed in Eastern Daylight Time
Barometric pressure	expressed in inches of mercury
Temperature	expressed in degrees Fahrenheit and centigrade
Humidity	relative, expressed as a percent
Wind Speed	expressed in knots
Wind Direction	direction from which the wind is moving

TABLE H.1

SURFACE METEOROLOGICAL DATA (NWS)

TEST DATE: June 13, 1983 HELICOPTER: S-76 Sikorsky LOCATION: DULLES AIRPORT*

TIME (EDT)	BAROMETRIC PRESSURE (INCHES)	TEMPERATURE °F(°C)	HUMIDITY (%)	WIND SPEED (MPH)	WIND DIRECTION (DEGREES)
05:29	30.11	59(15)	97	0	000
05:45	30.11	59(15)	97	0	000
06:00	30.11	59(15)	97	0	000
06:15	30.11	59(15)	97	0	000
06:30	30.12	60(15)	93	0	000
06:45	30.12	61(15)	93	0	000
07:00	30.13	62(17)	93	0	000
07:15	30.13	65(18)	93	0	000
07:30	30.13	67(19)	87	4	320
07:45	30.13	68(20)	87	5	330
08:00	30.14	69(20)	87	5	320
08:15	30.14	70(21)	87	4	320
08:30	30.14	73(23)	85	4	340
08:45	30.14	74(23)	85	5	350
09:00	30.14	75(24)	82	5	320
09:15	30.15	76(24)	79	4	340
09:30	30.15	77(25)	77	5	330
09:46	30.15	78(25)	74	6	330
10:03	30.15	79(26)	72	6	340

*Sensors located approximately 2 miles east of measurement array

TABLE H.2

SURFACE METEOROLOGICAL DATA (NWS)

TEST DATE: June 13, 1983 HELICOPTER: S-76 Sikorsky (CONT) LOCATION: DULLES AIRPORT*

TIME (EDT)	BAROMETRIC PRESSURE (INCHES)	TEMPERATURE °F(°C)	HUMIDITY (%)	WIND SPEED (MPH)	WIND DIRECTION (DEGREES)
11:15	30.16	80(27)	72	7	340
11:30	30.16	81(27)	69	6	340
11:45	30.16	81(27)	67	5	350
11:52	30.16	81(27)	67	7	330
12:16	30.16	83(28)	65	4	360
12:28	30.16	83(28)	64	7	020
12:45	30.16	84(29)	61	6	010
1:00	30.15	85(29)	59	7	320
2:00	30.15	87(30)	52	3	050
3:00	30.15	88(31)	52	4	290
4:00	30.15	90(32)	49	4	290

*Sensors located approximately 2 miles east of measurement array

APPENDIX I

On-Site Meteorological Data

This appendix presents a summary of meteorological data collected on-site by TSC personnel using a climatronics model EWS weather system. The anemometer and temperature sensor were located 5 feet above ground level at noise site 4. The data collection is further described in Section 5.5.

Within each table, the following data are provided:

Time(EDT)	expressed in Eastern Daylight Time
Temperature	expressed in degrees Fahrenheit and centigrade
Humidity	expressed as a percent
Windspeed	expressed in knots
Wind Direction	direction from which the wind is blowing
Remarks	observations concerning cloud cover and visibility

TABLE I.1

SURFACE METEOROLOGICAL DATA

TEST DATE: June 13, 1983 HELICOPTER: S-76 Sikorsky LOCATION: DULLES, SITE #4*

TIME (EDT)	TEMPERATURE °F(°C)	HUMIDITY (%)	WINDSPEED AVG (MPH)	WINDSPEED RANGE (MPH)	WIND DIRECTION (DEGREES)	REMARKS
05:30	54(12	90				Hazy 100% mist
05:45	54(12)					No sun
06:00	56(13)					Grass wet, ground moist
06:15	60(15)					
06:30	62(17)					
06:45	64(18)					
07:00	66(19)					
07:15	71(22)					
07:30	72(22)					
07:45	71(22)					
08:00	71(22)					
08:15	71(22)	68				Hazy and sunny
08:30	74(23)					No fog
08:45	76(24)					Grass wet, ground moist
09:00	78(25)					
09:15	79(26)					
09:30	80(27)					
09:45	81(27)					
10:00	82(28)					
10:15	83(28)					
10:30	84(29)	59				

SENSOR HEIGHT IS 5 FEET ABOVE GROUND

TABLE I.3

SURFACE METEOROLOGICAL DATA

TEST DATE: June 13, 1983 HELICOPTER: S-76 Sikorsky (CONT) LOCATION: DULLES, SITE #4*

TIME (EDT)	TEMPERATURE °F(°C)	HUMIDITY (%)	WINDSPEED AVG (MPH)	WINDSPEED RANGE (MPH)	WIND DIRECTION (DEGREES)	REMARKS
10:45	84(29)	56				Sunny hot
11:00	85(29)					Grass dry
11:15	86(30)					
11:30	86(30)					
11:45	88(31)					
12:00	86(30)					
12:15	87(30)					
12:30	87(30)					
12:45	88(31)					
1:00	88(31)	38				Sunny hot, grass dry

SENSOR HEIGHT IS 5 FEET ABOVE GROUND

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