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16. Abstract

This report documents the results of a Federal Aviation Administration (FAA) noise measurement flight test program with the Hughes 500D/E 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 third in a series of seven documenting the FAA helicopter noise measurement program conducted at Dulles International Airport during the summer of 1983. The Hughes 500D/E test program 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 assessing heliport environmental 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 acquired using international helicopter noise certification test procedures.

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HUGHES 500D/E

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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 Hughes 500D 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 third in a series of seven documenting the FAA helicopter noise measurement program conducted at Dulles International Airport during the summer of 1983.

The Hughes test program was conducted by the FAA in cooperation with Hughes Helicopter, Inc., and a number of supporting Federal agencies. The rigorously controlled tests involved the acquisition of detailed acoustical, position and meteorological data.

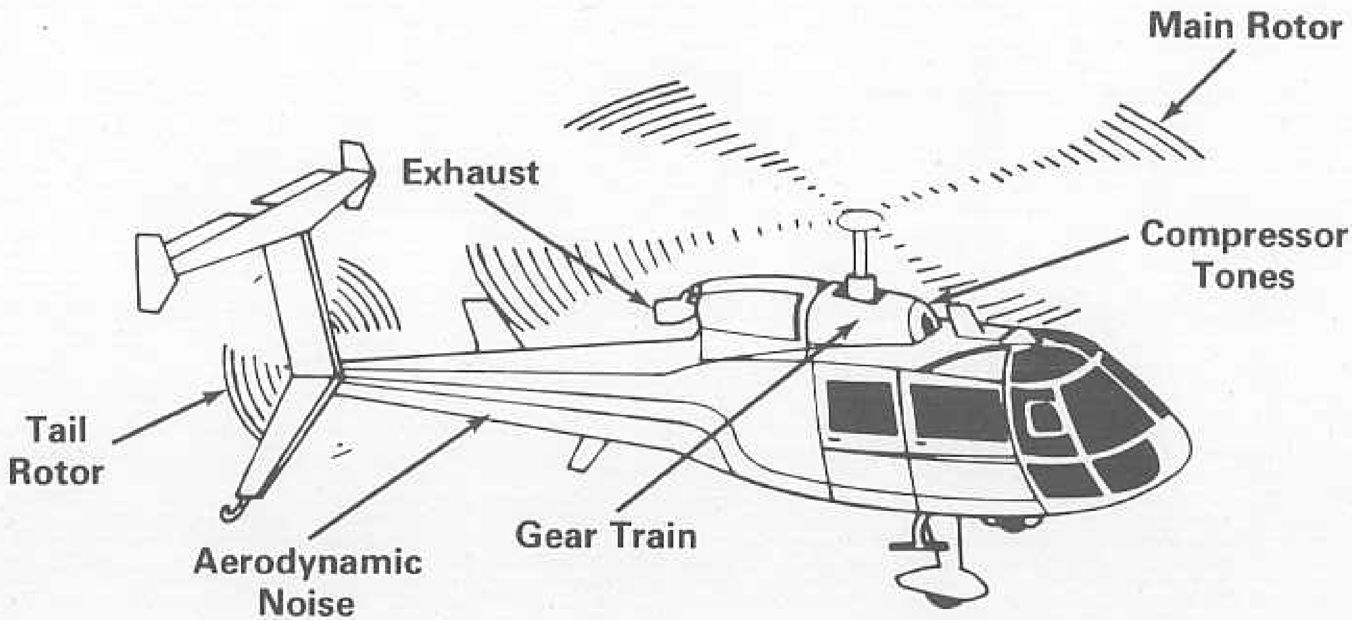
This test program was designed to address a series of objectives including: 1) acquisition of acoustical data for use in heliport environmental impact analyses, 2) documentation of directivity characteristics for static operation of helicopters, (3) establishment of ground-to-ground and air-to-ground 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 9.14) 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 Hughes 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



TEST HELICOPTER DESCRIPTION

2.0 Test Helicopter Description - The Hughes 500D is a single turboshaft engine-powered helicopter with a five-bladed main rotor. The tail rotor has two blades on a standard unit or four blades on an optional, low noise unit, which was used for this test. The helicopter is manufactured by Hughes Helicopters, Inc., (a subsidiary of McDonnell Douglas, Inc.) of Culver City, California and was certificated by the FAA in December of 1976. The 1983 tests were actually conducted with the Hughes 500D, a helicopter that has been replaced with the Hughes 500E. The D and E models have identical rotor and propulsion systems, weights and capabilities; the only difference, in fact, is a cosmetic one. Thus, all of the data presented herein for the D model are equally applicable to the E.

The aircraft generally carries a pilot and four passengers with 42 cubic feet of baggage space, but it may be adapted to carry seven (with only 11 cubic feet of baggage space). A special feature of the aircraft is the small T tail which gives the helicopter more stability in flight and better handling characteristics in abnormal flight manuevers.

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	: Hughes Helicopters, Inc.
HELICOPTER MODEL	: 500 D (Similar to the 500 E)
HELICOPTER TYPE	: Single Rotor
TEST HELICOPTER N-NUMBER	: N 5011R
MAXIMUM GROSS TAKEOFF WEIGHT	: 3000 lbs (1361 kg)
NUMBER AND TYPE OF ENGINE(S)	: 1 Detroit Diesel Allison 250-C20B
SHAFT HORSE POWER (PER ENGINE)	: 420 hp (installed) 375 hp (T/O power)
MAXIMUM CONTINUOUS POWER	: 350 hp
SPECIFIC FUEL CONSUMPTION AT MAXIMUM POWER (LB/HR/HP)	: 0.68 lb/hr/hp
NEVER EXCEED SPEED (V_{NE})	: 152 kts
MAX SPEED IN LEVEL FLIGHT WITH MAX CONTINUOUS POWER (V_H)	: 139 kts (sea level standard day)
SPEED FOR BEST RATE OF CLIMB (Vy)	: 62 kts (sea level standard day)
BEST RATE OF CLIMB	: 1900 fpm

MAIN AND TAIL ROTOR SPECIFICATIONS

	MAIN	TAIL
ROTOR SPEED (103% standard)	: 492 RPM	2332 RPM
DIAMETER	: 26.41 ft	4.25 ft
CHORD	: .562 ft constant	.442 ft constant
NUMBER OF BLADES	: 5	4
PERIPHERAL VELOCITY	: 680.4 fps	519 fps
BLADE LOAD	: 80.85 lbs/ft^2	----------
FUNDAMENTAL BLADE PASSAGE FREQUENCY	: 41 Hz	77.7 Hz
ROTATIONAL TIP MACH NUMBER (77°F)	: .60	.46

TABLE 2.2

ICAO REFERENCE PARAMETERS

	TAKEOFF	APPROACH	LEVEL FLYOVER
AIRSPEED (KTS)	: 62	62	137
RATE OF CLIMB/DESCENT (fpm)	: 1900	657	NA
CLIMB/DESCENT ANGLE (DEGREES)	: 17.6°	6°	NA
ALTITUDE/CPA (FEET)			
SITE 5	: 430/410	342/340	492
SITE 1	: 586/559	394/392	492
SITE 4	: 742/708	446/443	492
SLANT RANGE (FEET) TO			
SITE 2	: 716	630	696
SITE 3	: 716	630	696

TEST SYNOPSIS

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: Hughes 500D

3. Test Date: Wednesday, June 22, 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.

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 3.1

Flight Test and Noise Measurement Personnel In Action

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

Figure 3.2

The Terminal and Air Traffic Control Tower
at Dulles International Airport

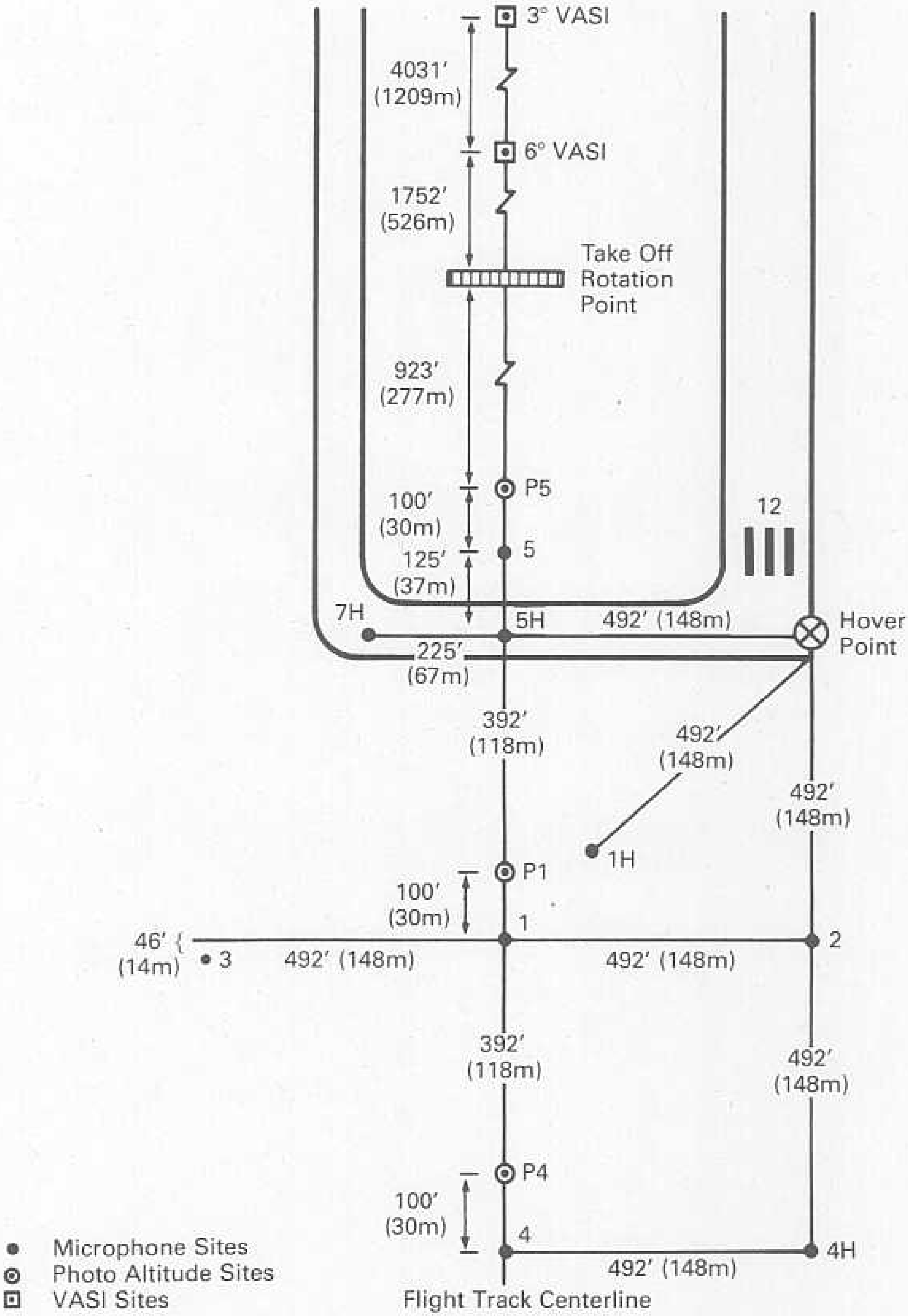
Approach to Runway 12 at Dulles Noise
Measurement Site for 1983 Helicopter Tests

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 6, 9 and 12 degree glide slopes.

FIGURE 3.3
Noise Measurement and Photo Site Schematic



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

TEST PLANNING AND BACKGROUND

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.

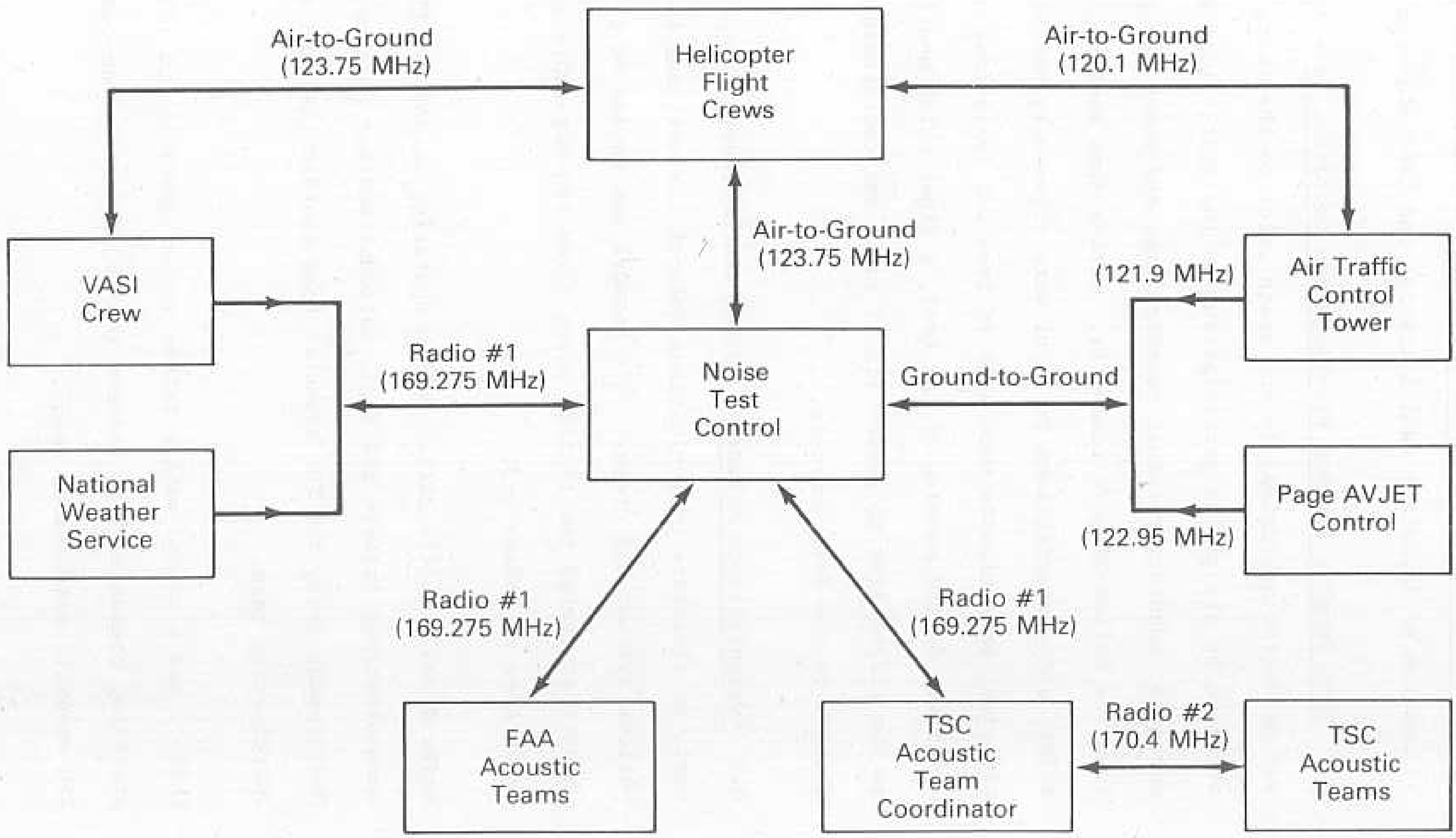
4.2 Communications Network - During the helicopter noise measurement test, an elaborate communications network was utilized to manage the various systems and crews. This network was headed by a central group which coordinated the testing using three two-way radio systems, designated as Radios 1-3.

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.

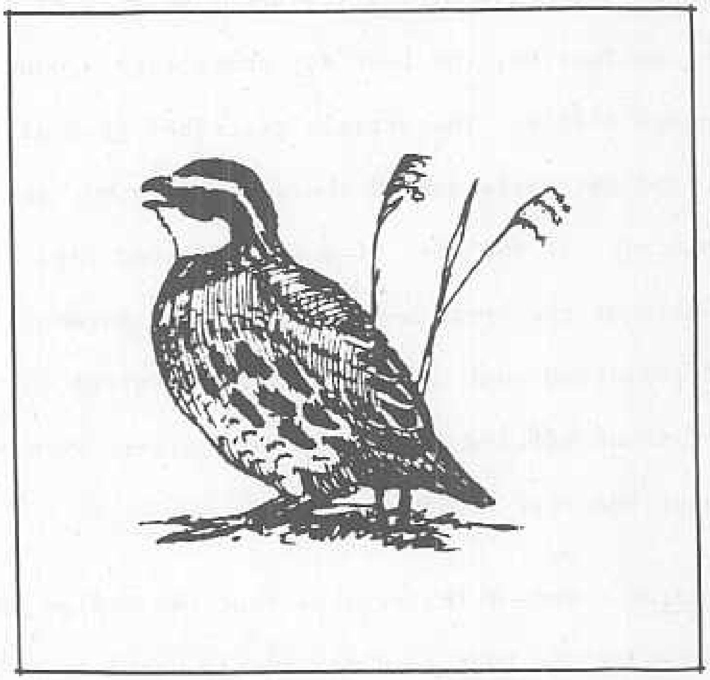
A schematic of this network is shown in Figure 4.1.

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 22, 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 may be found in Figure 4.2.

As an additional measure for safety and for lessening ambient noise, a Notice to Airment 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



DATA ACQUISITION AND GUIDANCE SYSTEMS

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 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 <u>Photo Altitude Determination Systems</u> - 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.

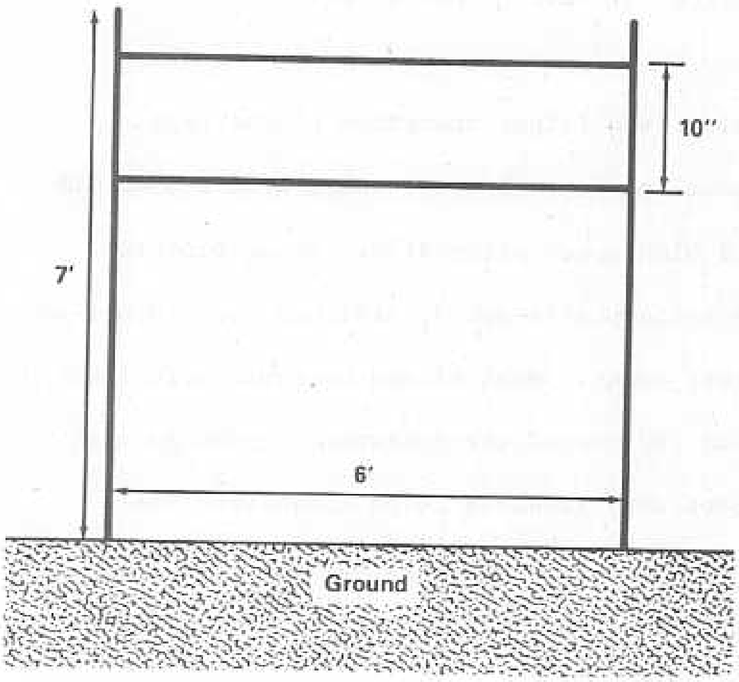
The photoscaling technique assumes the aircraft is photographed directly overhead. Although SAE AIR-902 does present equations to account for deviations caused by photographing too soon or late, or by the aircraft deviating from the centerline, these corrections are not required when deviations are small.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

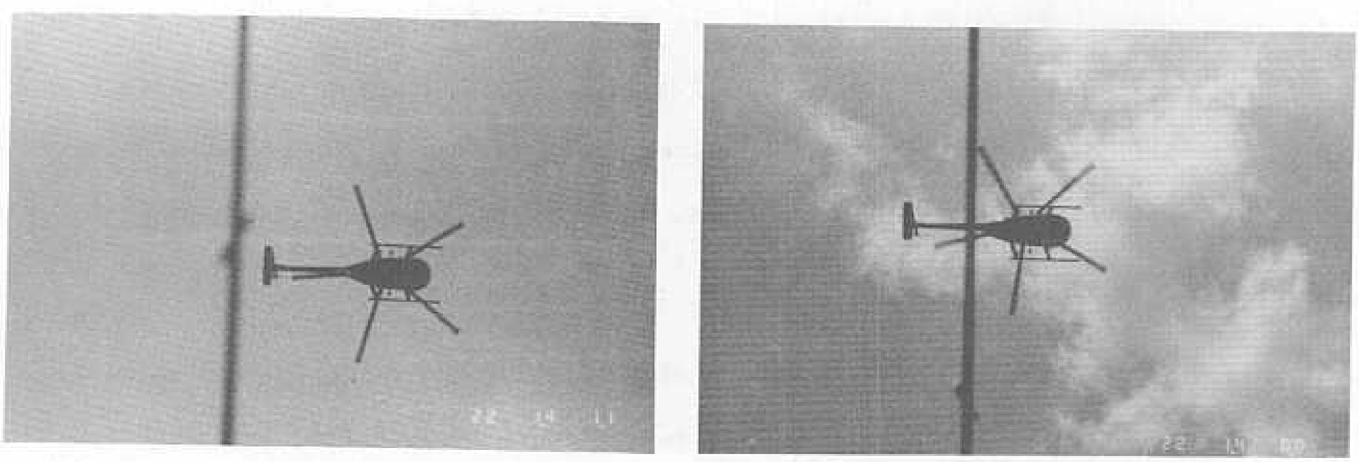
Figure 5.1

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 Hughes 500D, as taken by the photographer using the POP system.

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. When slides were projected onto a screen, it was possible to read and record the instrument readings with reasonable accuracy. 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. 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.

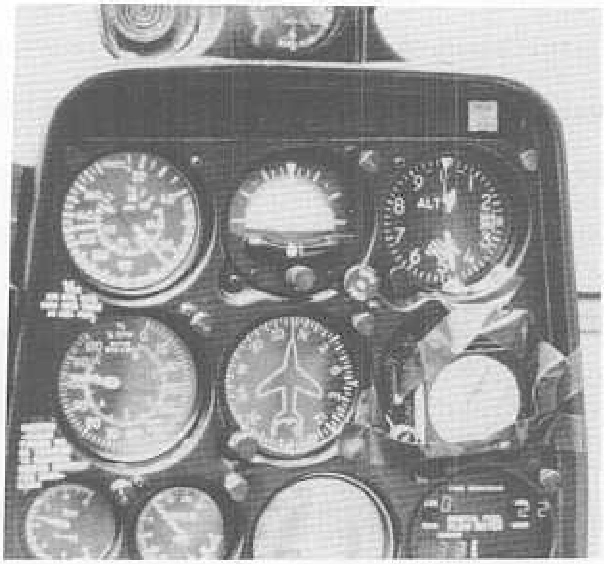


FIGURE 5.2

5.4 <u>Upper Air Meteorological Data Acquisition/NWS: Sterling, VA</u> - 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 continous trace on a strip chart recorder. The levels were than 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 1050 mb 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° Mech 0-540° Elect	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	0-540°	±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.

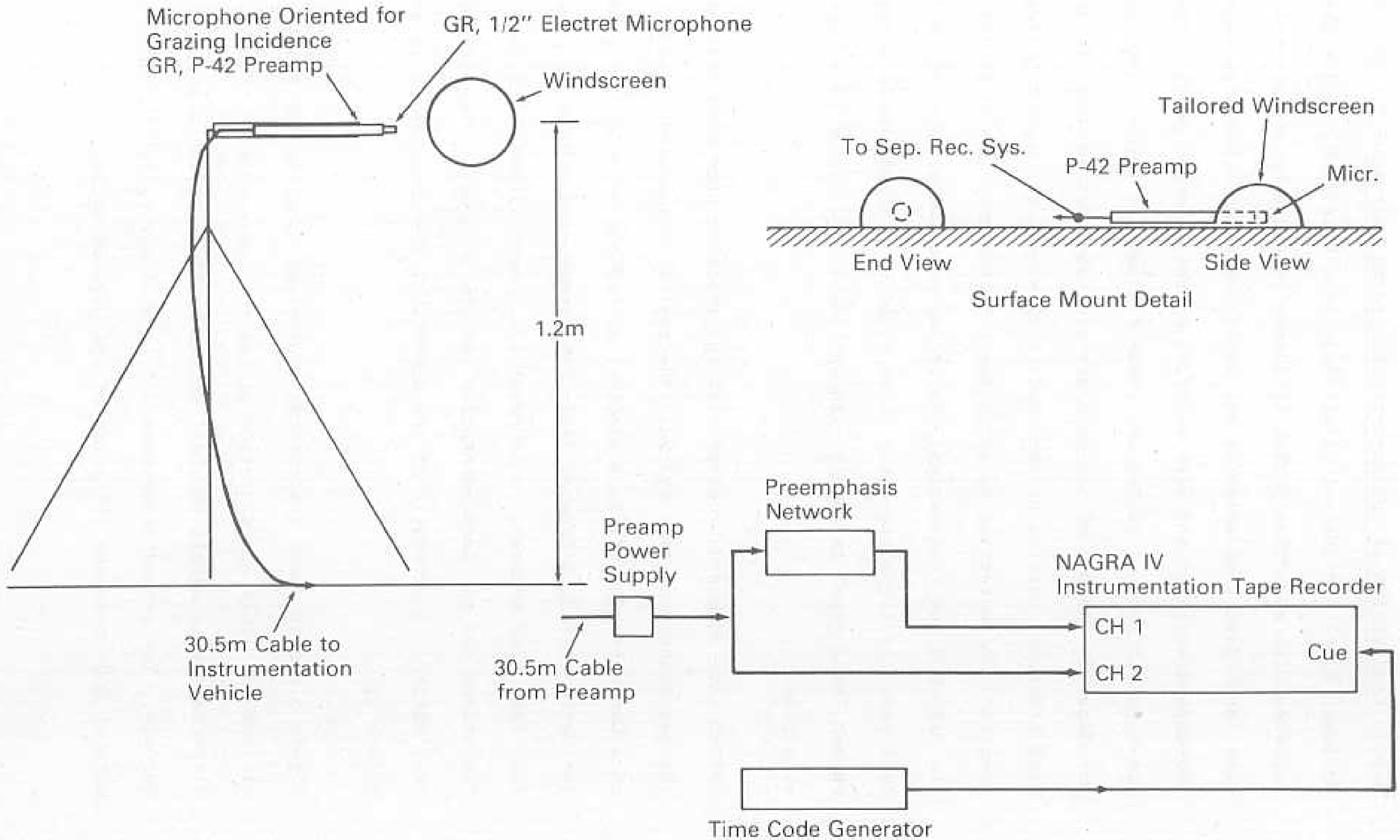
5.6.1 Description of TSC Magnetic Recording Systems - TSC personnel deployed Nagra two-channel direct-mode tape recorders. Noise data were recorded with essentially flat frequency response on one channel. The same input data were weighted and amplified using a high frequency pre-emphasis filter and were 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.

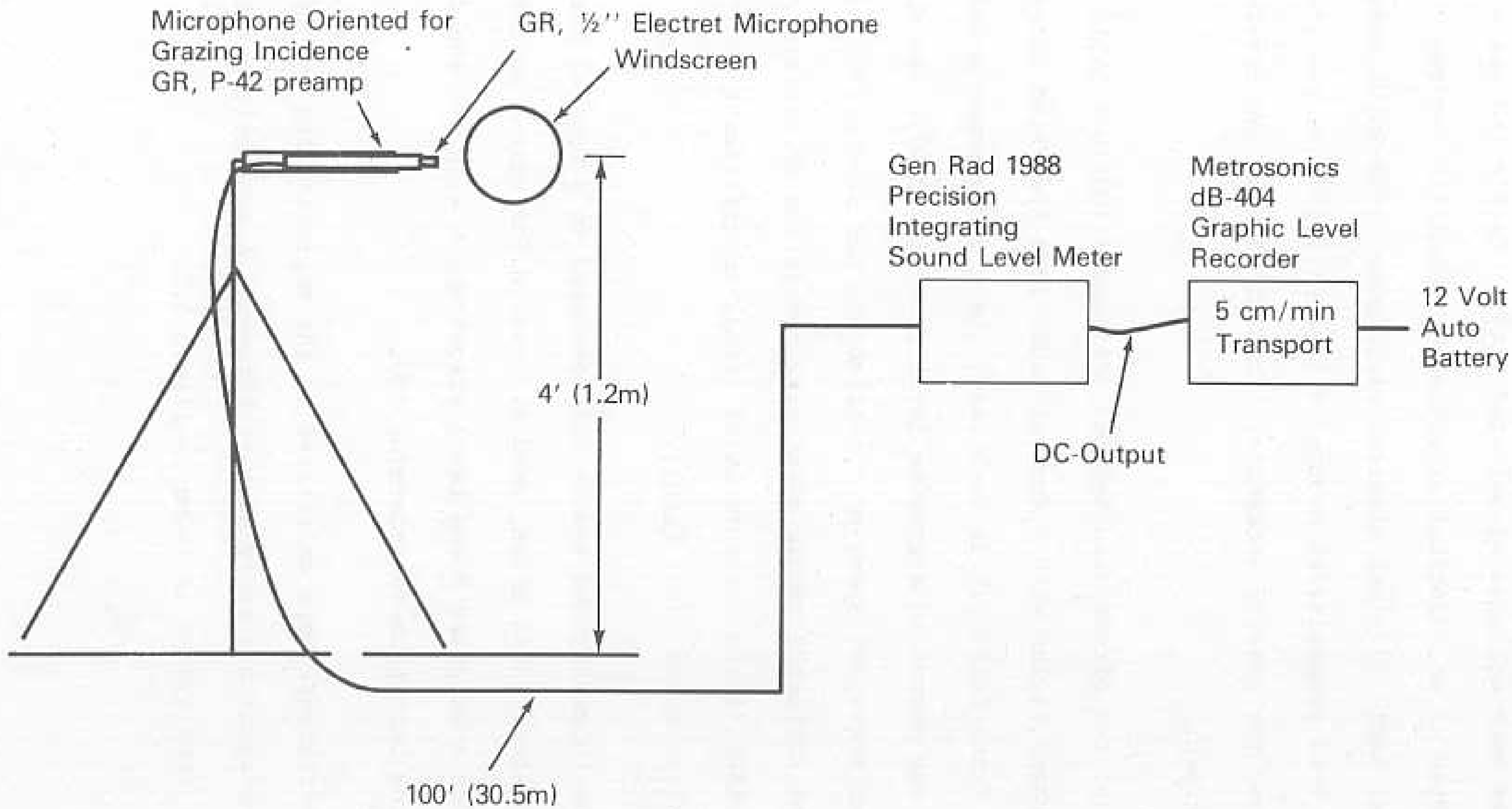
Three of the direct read systems utilized a 100-foot cable connecting the microphone system with a General Radio 1988 Precision Integrating Sound Level Meter (PISLM). In each case, the slow response A-weighted sound level was output to a graphic level recorder (GLR). The GLRs operated at a paper transport 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.

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

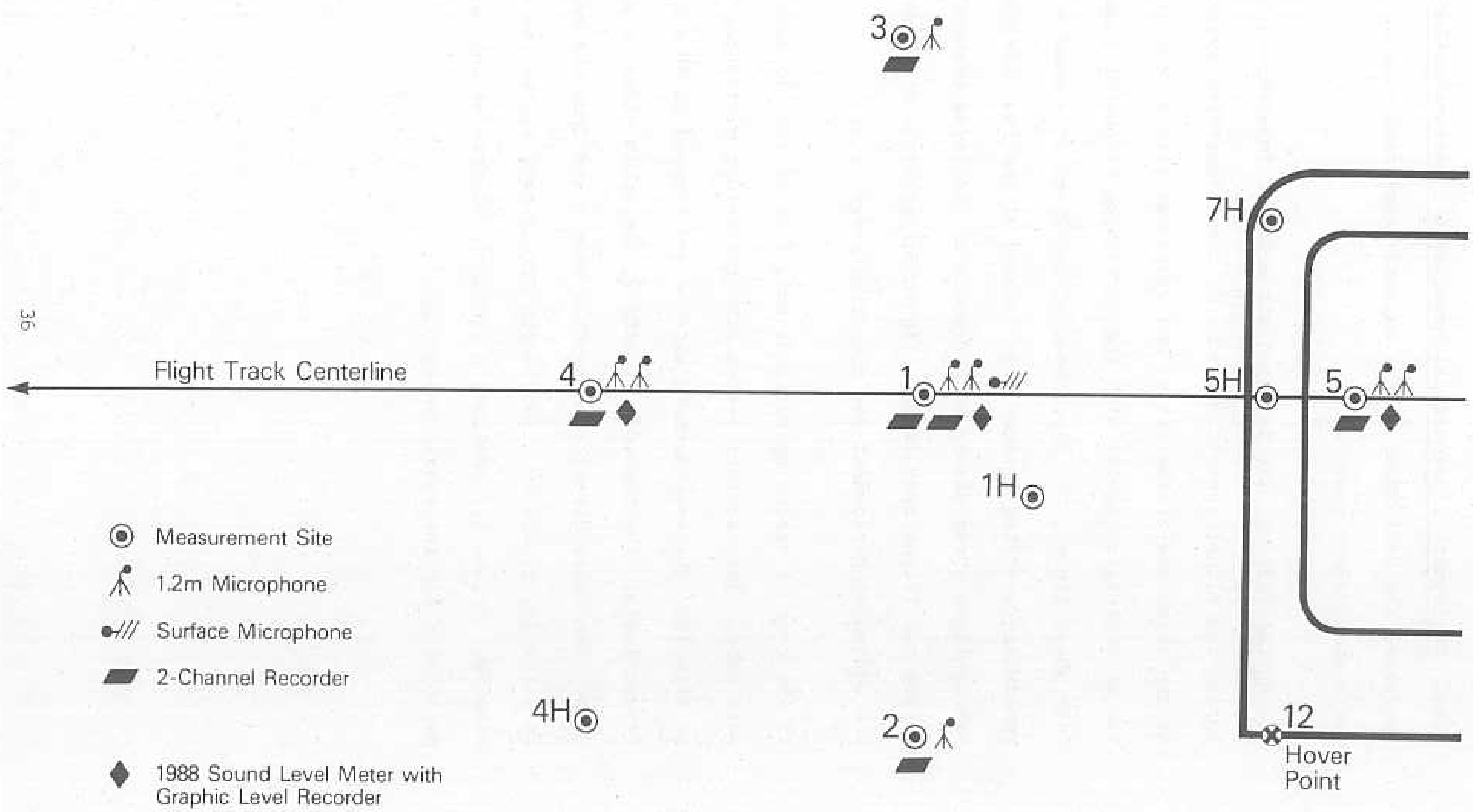
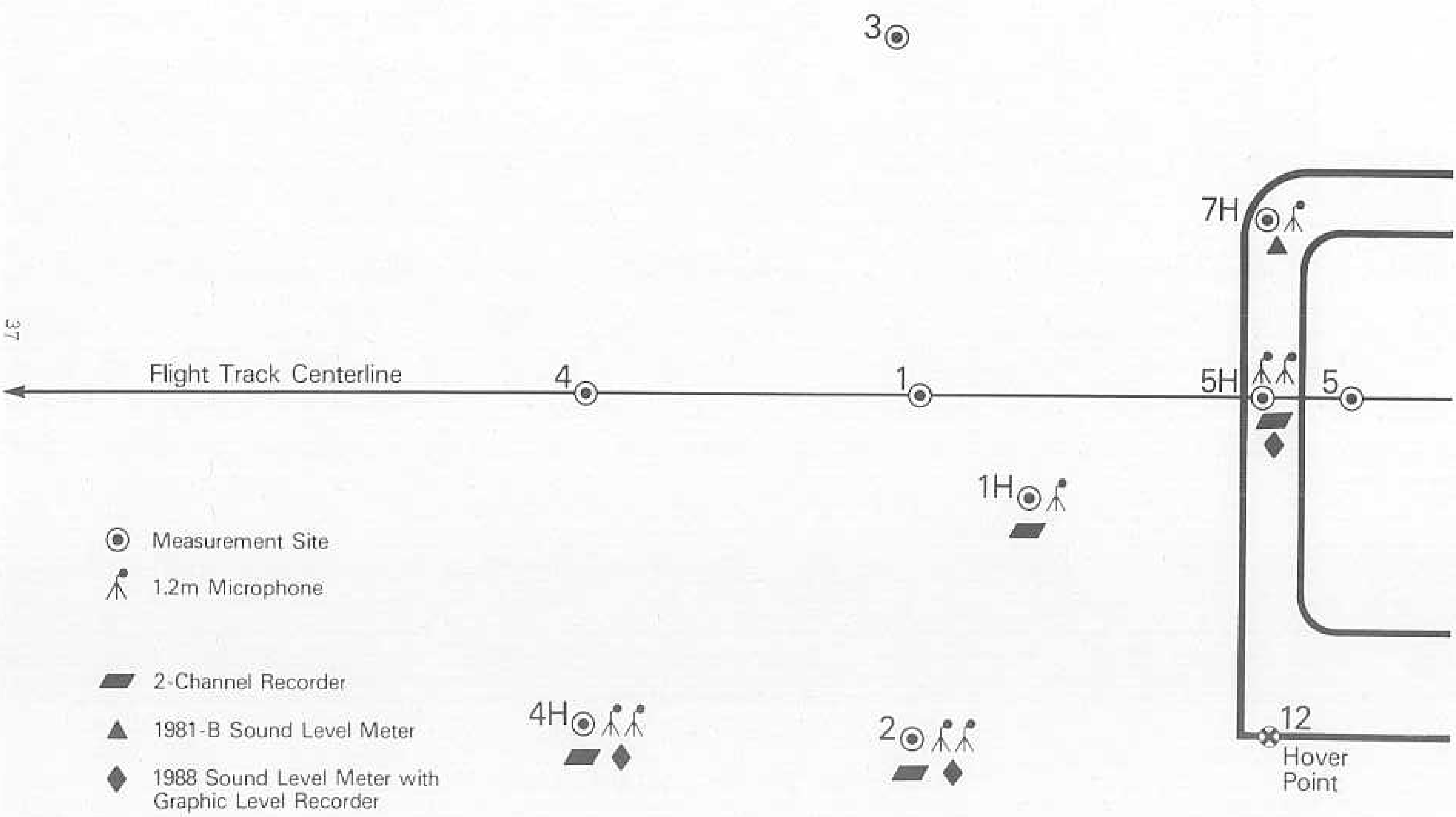


FIGURE 5.7
Microphone and Acoustical Measurement Instrument Deployment Static Operations



ACOUSTICAL DATA REDUCTION

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 is a flow chart of the data collection, reduction and output process accomplished 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

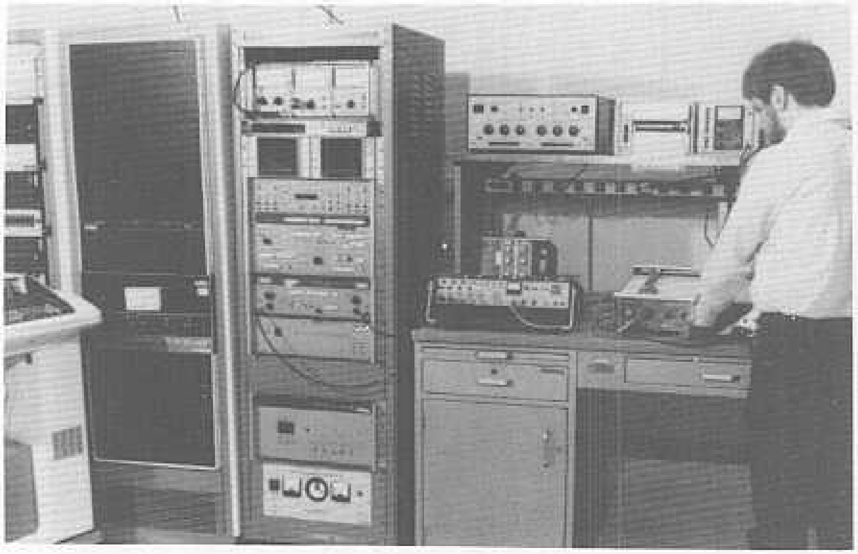
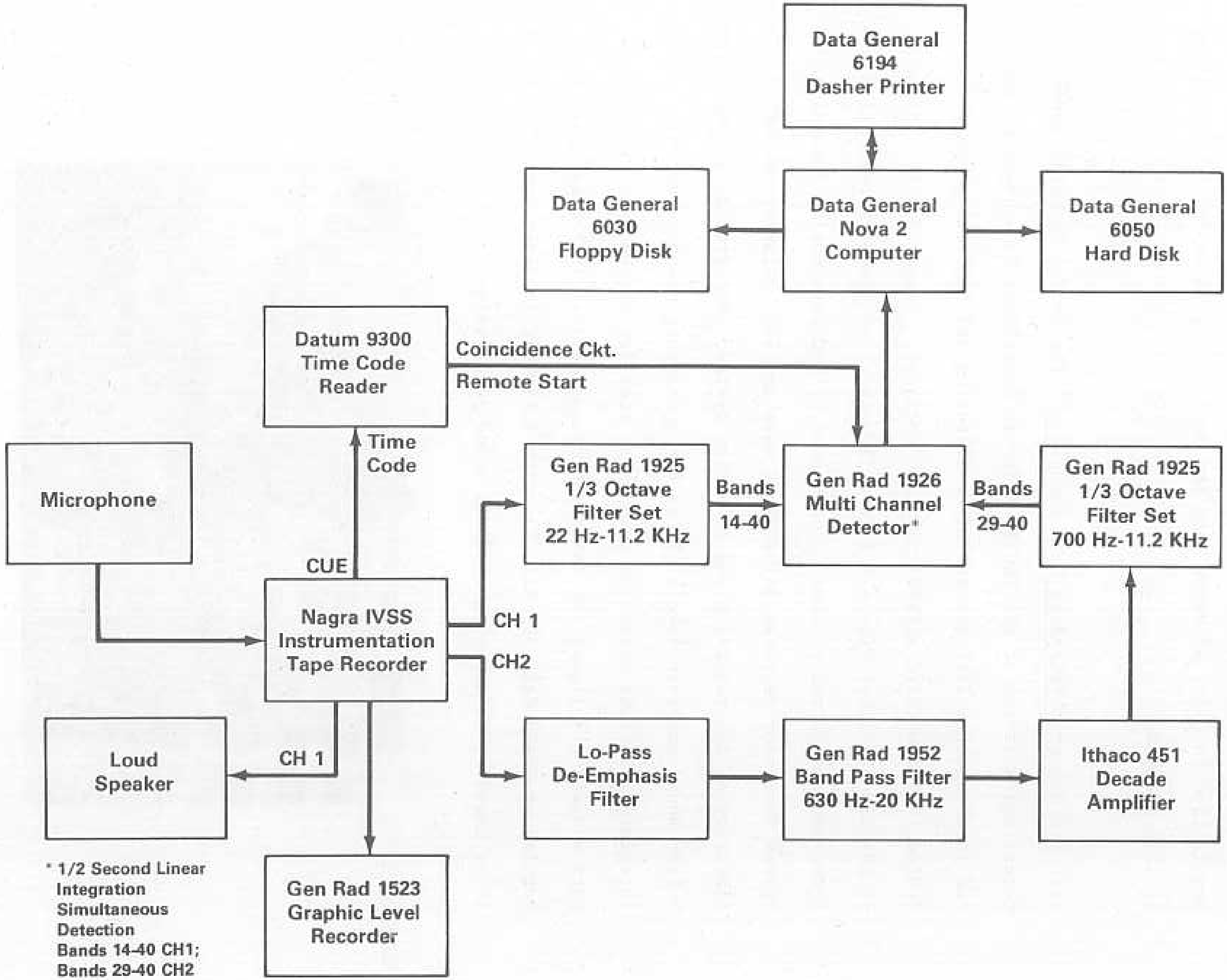


FIGURE 6.2

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 substracting the ambient level from the measured noise levels on an energy basis. This substraction 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)

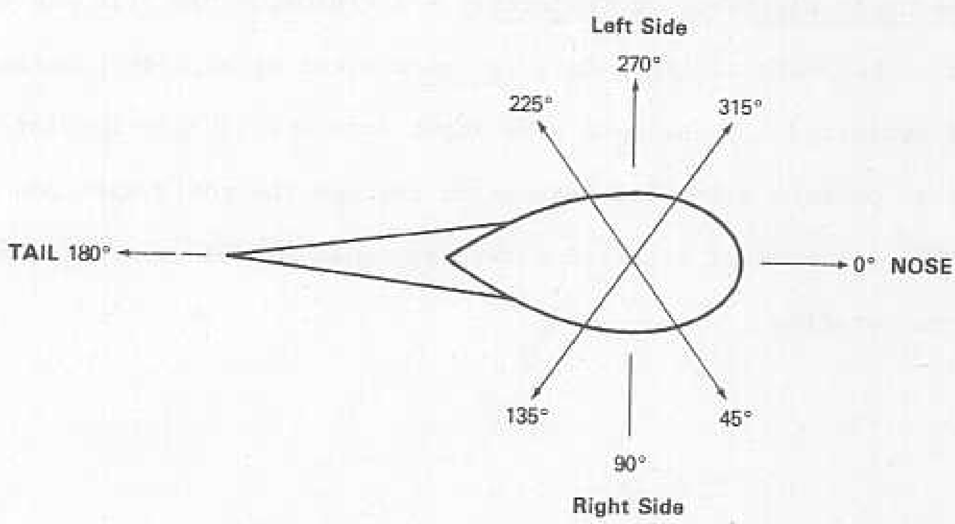
6.1.6 Other Metrics - In addition to the EPNL/PNLT family of metrics and the SEL/AL family, the overall sound pressure level and 10-dB down duration times are presented as part of the "As Measured" data set in Appendix A. Two factors relating to the event time history (distance duration and speed corrections,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



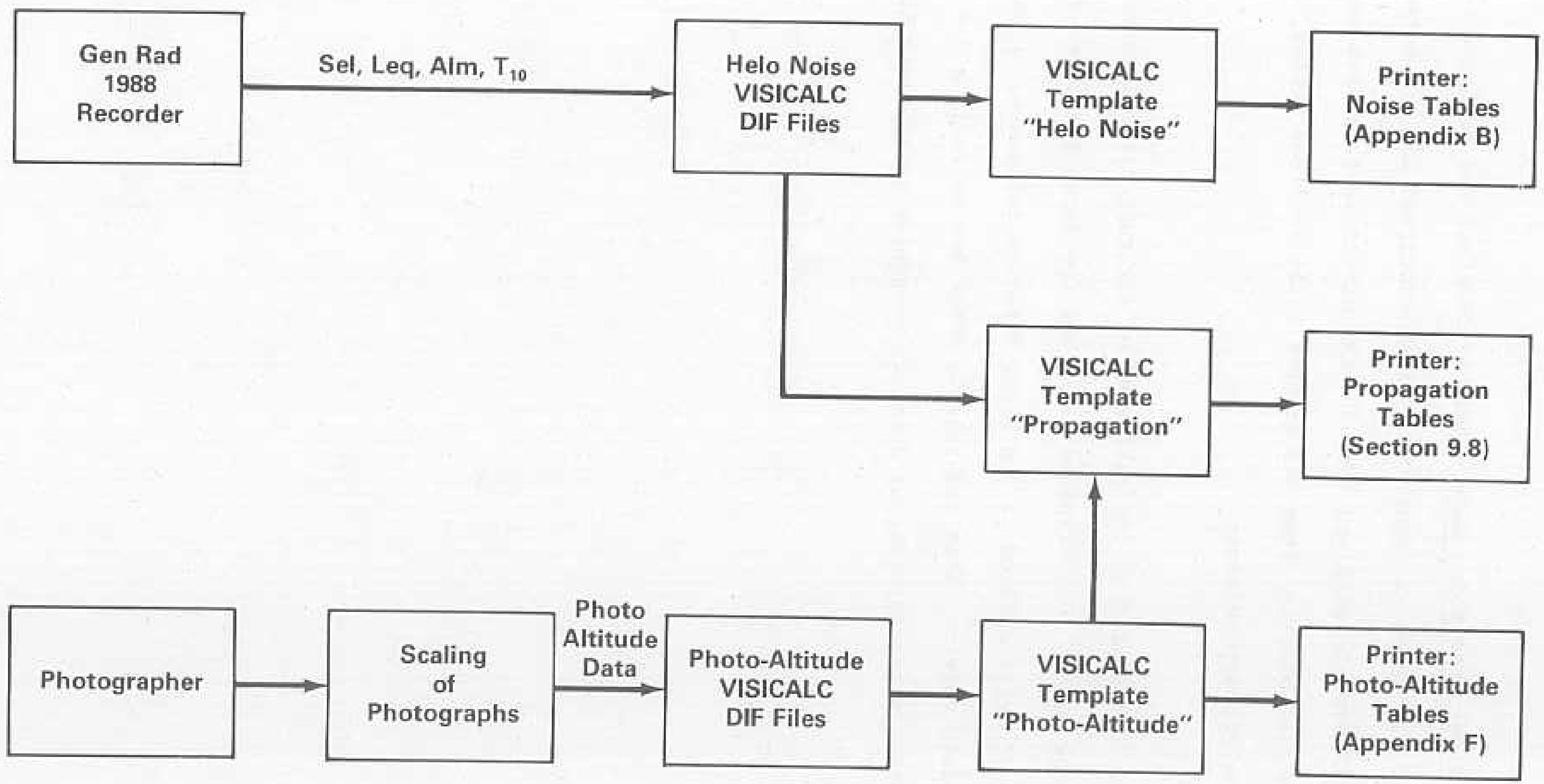
6.2 FAA Direct Read Data Reduction - Figure 6.4 provides a flow diagram of the data collection, reduction and output process effected by FAA personnel. FAA direct read data was reduced using the Apple IIe microcomputer and the VISICALC® software package. VISICALC® is an electronic worksheet composed 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.

FIGURE 6.4

Direct Read Data Reduction



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 strips, 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.

TEST SERIES DESCRIPTION

7.0 Test Series Description - The noise-flight test operations schedule for the Hughes 500D 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

TABLE 7.1

TEST SUMMARY

HUGHES 500D

TEST SERIES AND RUN NUMBERS	DESCRIPTION OF SERIES	START TIME	FINISH TIME	NOTES
M	Hover in ground effect	5:45 am	5:57 am	8 dir angles
N(A)	Static/flight idle RPM	5:59 am	6:20 am	8 dir angles
N(B)	Static/ground idle RPM	5:59 am	6:20 am	8 dir angles
	DUE TO POOR VISIBILITY THE TEST PROGRAM WAS DELAYED			
F/F1-F6	6 deg approach, 62 kts	11:00 am	11:15 am	
G/G7-G11	6 deg approach, 72 kts	11:16 am	11:28 am	
H/H12-H16	6 deg approach, 52 kts	11:32 am	11:51 am	
I/I17-I22	ICAO takeoff, 62 kts	11:57 am	12:16 am	
		FUEL BREAK		
J/J23-J26	9 deg approach, 62 kts	12:55 pm	1:02 pm	
K/K27-K32	direct climb takeoff	1:06 pm	1:21 pm	
L/L33	12 deg approach, 62 kts	1:24 pm	1:27 pm	
		FUEL BREAK		
L/L34-L37	12 deg approach, 62 kts	2:00 pm	2:12 pm	
A/A38-A44	LFO, 500 ft./0.9 VH	2:19 pm	2:39 pm	
B/B45-B49	LFO, 500 ft./0.8 VH	2:40 pm	2:49 pm	
C/C50-C53	LFO, 500 ft/0.7 VH	2:50 pm	3:56 pm	
D/D54-D57	LFO, 500 ft./0.6 VH	2:59 pm	3:07 pm	
E/E58-E60	LFO, 1000 ft./0.9 VH	3:14 pm	3:17 pm	

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.

The "standard takeoff" operation, elected by the manufacturer, consisted of a direct climbout from a 5-foot hover, using the best angle of climb. The reader is referred to Appendices E and F for appropriate cockpit instrument and trajectory information necessary to fully characterize this operation.

Figures 7.1, 7.2 and 7.3 present the test flight configuration for the ICAO takeoff, approach and level flyover operations. A schematic of the actual flight tracks is available in Figure 3.3.

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;

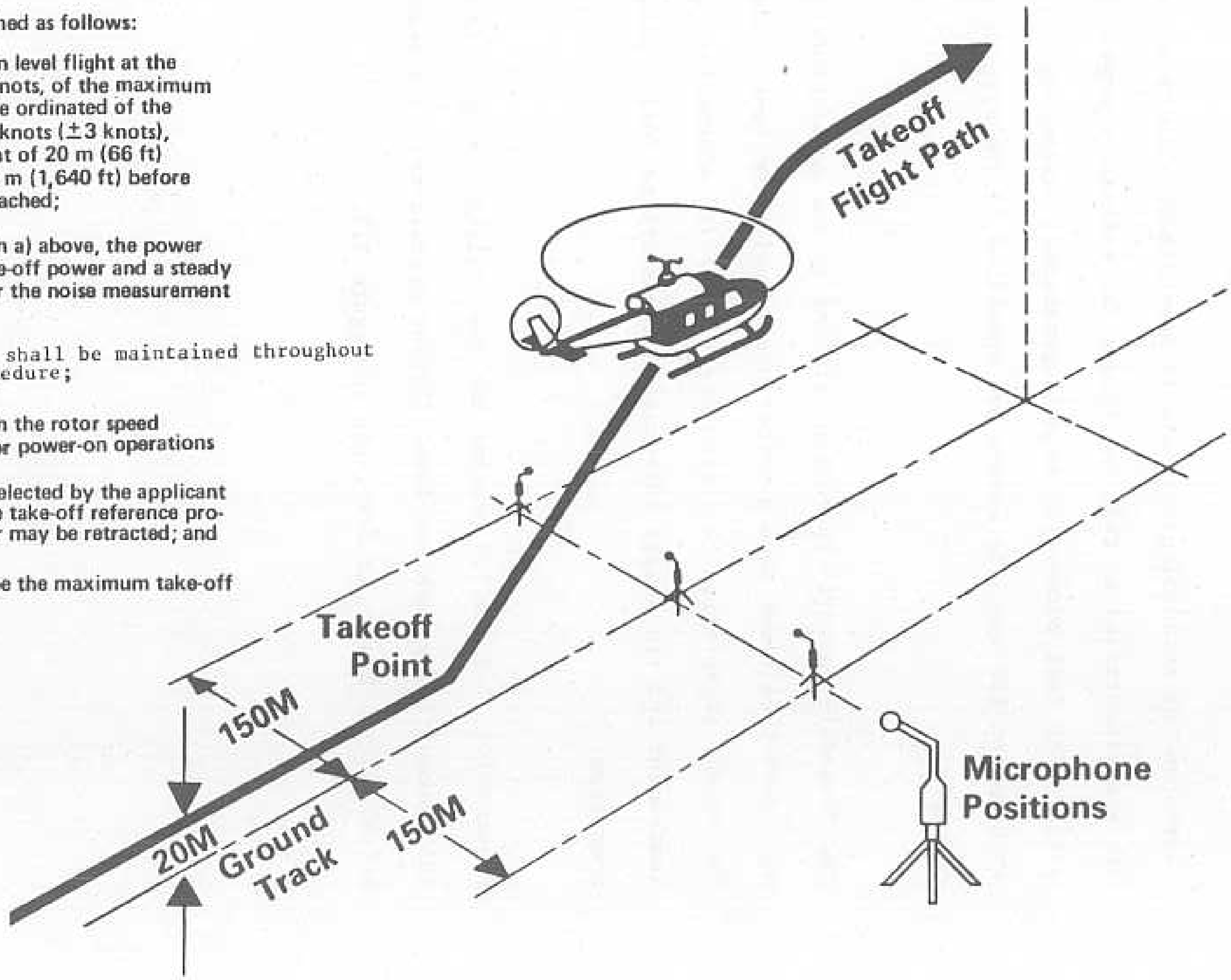
b) upon reaching the point specified in a) above, the power shall be increased to maximum take-off power and a steady climb initiated and maintained over the noise measurement time period;

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.



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

FIGURE 7.2

Helicopter Approach Noise Tests

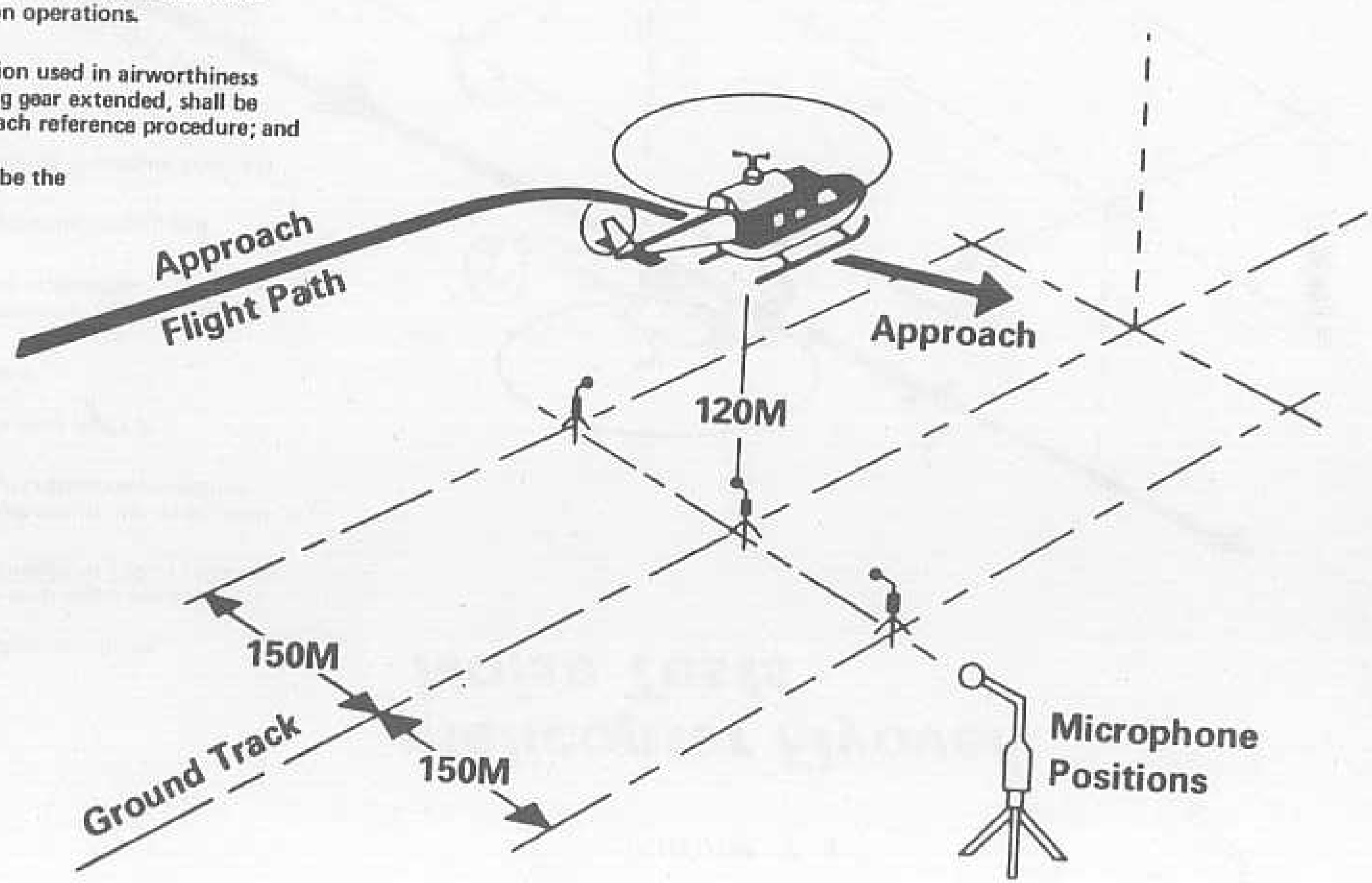


FIGURE 7.3

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);

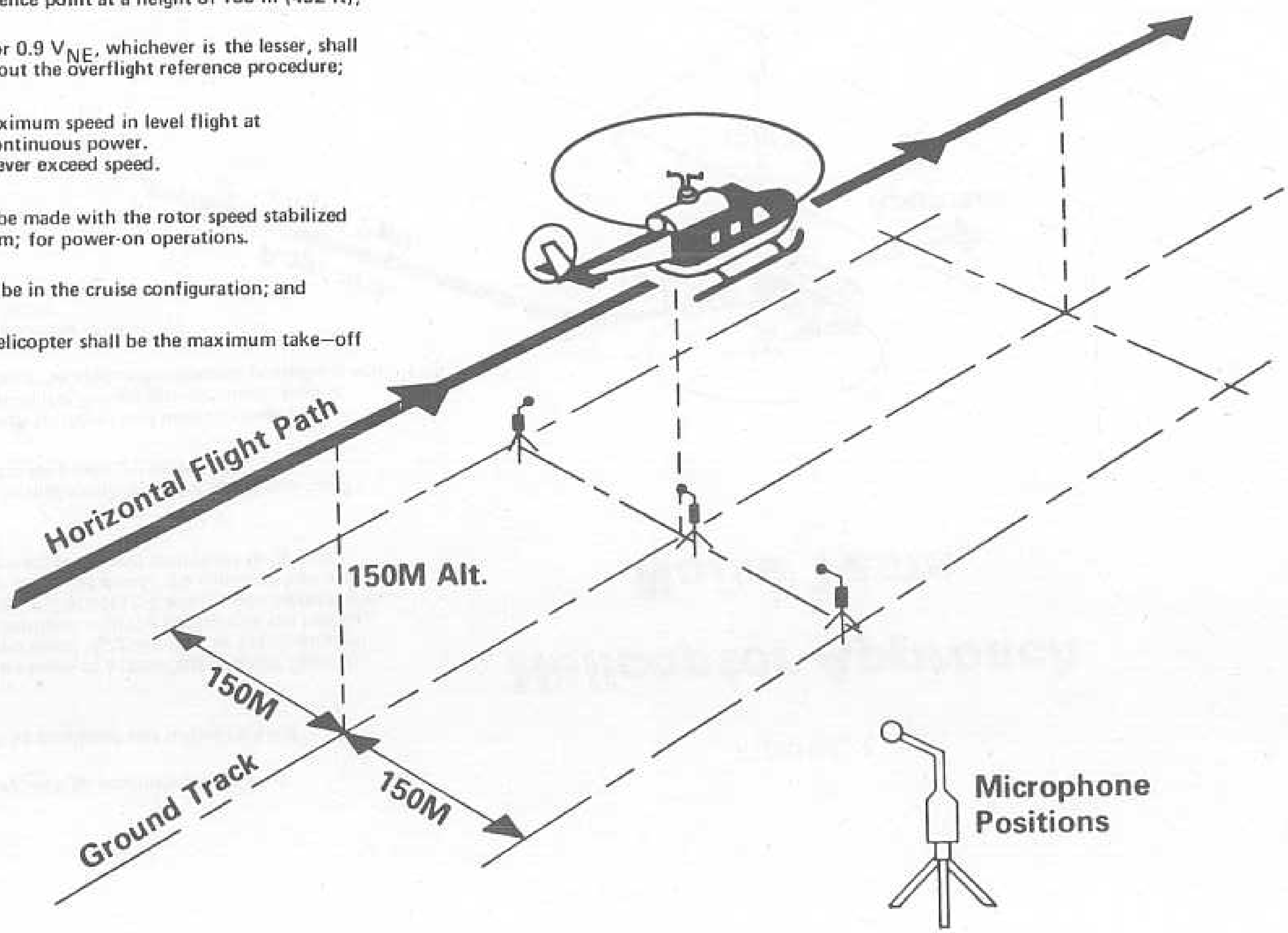
b) a speed of 0.9 V_H or 0.9 V_{NE}, whichever is the lesser, shall be maintained throughout the overflight reference procedure;

NOTE: 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.



DOCUMENTARY ANALYSES

8.0 <u>Documentary Analyses/Processing of Trajectory and Meteorological Data</u> - This section contains analyses which were performed to document the flight path trajectory and upper air meteorological characteristics during the Hughes 500D test program.

8.1 <u>Photo-Altitude Flight Path Trajectory Analyses</u> - Data acquired from the three centerline photo-altitude sites were processed on an Apple IIe microcomputer using a VISICALC® (manufacturer) electronic spread sheet 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.

<u>Discussion</u> - 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)

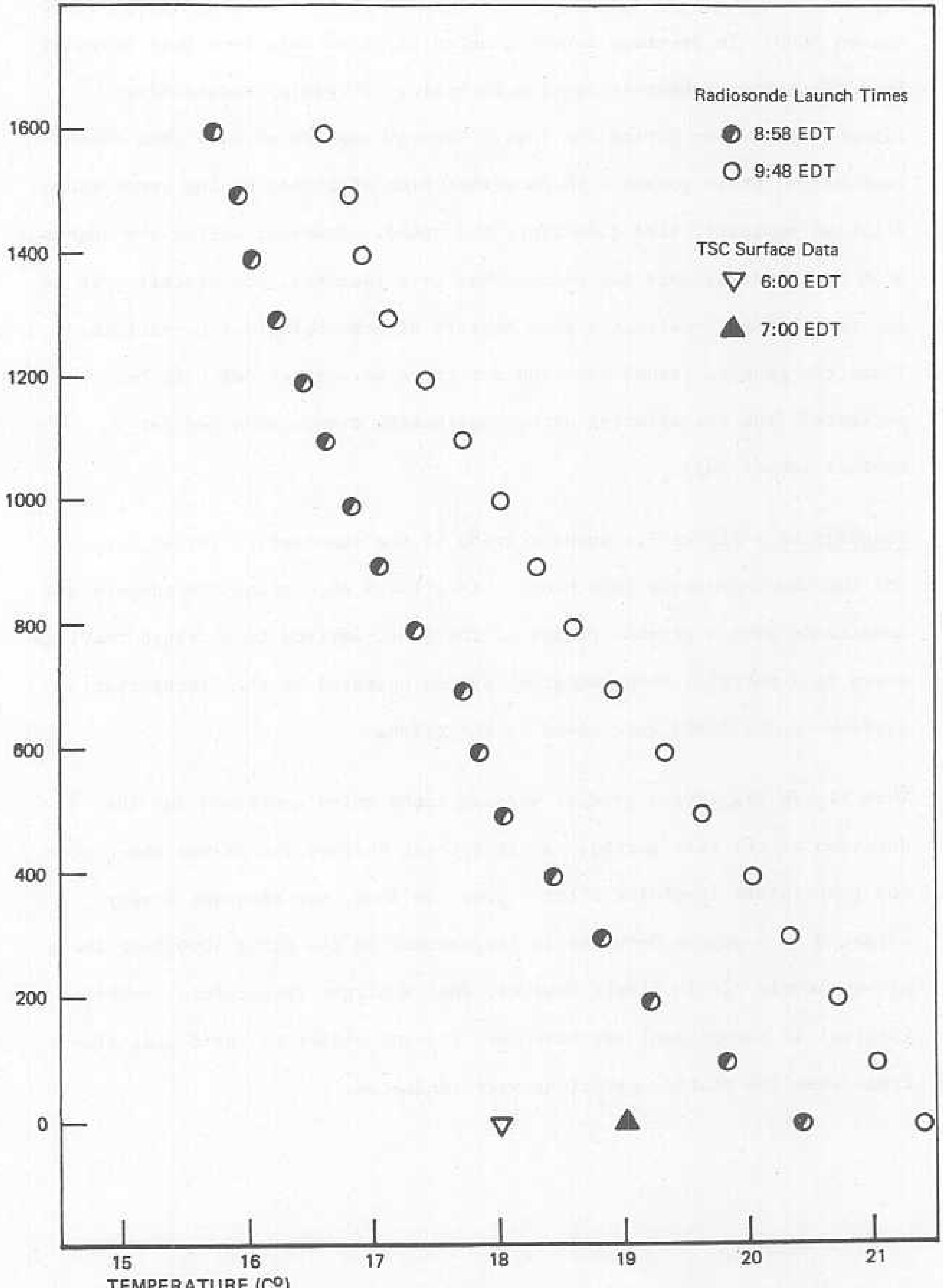
Further, care is necessary when using the regression slope and the regression estimated altitudes; one must be sure that the site-to-site slopes are similiar (approximate constant angle) and that they are in agreement with the regression slope. If these slopes are not in agreement, then use photo altitude 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 - The purpose of this section is to report the general trends of the meteorological conditions during the testing of the Hughes 500D. In previous reports, meteorological data have been provided from the National Weather Service (Sterling, Virginia) radiosondes launched each hour during the test. Through the use of data from these launchings, it is possible to construct time histories of the temperature, relative humidity, wind direction, and speed. However, during the Hughes 500D test period, only two radiosondes were launched; consequently, it is not possible to construct a time history of meteorological conditions. Thus, the general trends expected for these parameters can only be estimated from the existing data, considering trends expected for a typical summer day.

Temperature - Figure 8.1 shows a graph of the temperature versus altitude for the two radiosonde launchings. In efforts to display the temperature conditions over a greater period of the test, surface temperature readings taken by a portable meteorological system operated by the Transportation Systems Center (TSC) were added to the graph.

This figure displays a gradual warming trend which continued for the duration of the test period. A significant obersvation is the absence of any temperature inversion after 9 a.m. In fact, one observes a very normal 3 to 4 degree decrease in temperature in the first 1000 feet above ground level. It is likely however, that a slight temperature inversion (typical in summertime) may have been present closer to the 6 a.m. time frame when the static operations were conducted.

FIGURE 8.1 TEMPERATURE VS ALTITUDE



Relative Humidity - Relative humidity data are shown in Appendix I. It is seen that relative humidity decreases with time (as one would expect) as solar heating burns off the ground moisture. The relative humidity data presented in Appendix I can be used along with temperature information to estimate acoustical absorption coefficients. The Table below (Table 8.1) displays the variations in relative humidity one would expect with the daily summer burn off of surface moisture and the dissipation of the inversion layer.

Table 8.1

RELATIVE HUMIDITY VS TIME LAUNCHING

Altitude	7:58 am RH (percent)	8:48 am RH (percent)
0	86	81
500	93	87
1000	97	94
2000	95	98

Wind data - Radiosonde wind data are shown in Appendix H while surface wind information is presented in Appendix I. It is evident that wind vector data acquired from the radiosonde launches (up to 1000 feet above the ground) are light and variable, generally in the vicinity of 5 kts. For the flight portion of the noise test, conducted after 11 am, one must consult ground surface meteorological data. TSC field met data presented in Appendix I shows that wind speeds remained very low (less than 3 knots) throughout the main portion of flight operations. In a few instances, however, the (15 minute average) wind reached approximately 7 knots.

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 Aerospatiale TwinStar 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 Comparison of noise data: 4-foot vs. ground microphones

9.4 Duration effect analysis

9.5 Analysis of variability in noise levels for two sites equidistant over similar propagation paths

9.6 Variation in noise levels with airspeed and rate of descent for approach operations

9.7 Analysis of ground-to-ground acoustical propagation for a nominally soft propagation path

9.8 Air-to-ground acoustical propagation analysis

9.1 Variation in Noise Levels with Airspeed for Level Flyover Operations - This section analyzes the variation in noise levels for level flyover operations as a function of airspeed. Data acquired from the centerline-center location (site 1) magnetic recording system (see Appendix A) have been utilized in this analysis. All data are "as measured", uncorrected for the minor variations in altitude from event to event.

The data scatter plotted in Figures 9.1 through 9.4 represent individual noise events (for each acoustical metric). The line in each plot links the average observation at each target airspeed.

Discussion - The plots show the general trend that can be expected with an increase in airspeed during level flyover operations. 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 parabolic curve. At first, noise levels decrease with airspeed, then an upturn occurs at as a consequence of increasing advancing blade tip Mach number effects, which in turn generate impulsive noise.

The noise versus airspeed plots for the Hughes 500D are shown for various acoustical metrics in Figures 9.1 through 9.4. Each of these plots displays a very weak sensitivity for the range of airspeeds considered. It is likely that the curve would gradually turn upward if higher airspeed data were added. For the other helicopters, it has been observed that noise increases rapidly when the Mach number advances beyond 0.8. The weak airspeed-noise relationship displays a minimum at approximately 115 knots. A table (Table 9.1) is provided below showing the relationship between indicated airspeed and advancing blade tip Mach number (M_A) for the Hughes 500D.

Table 9.1

INDICATED AIRSPEED VS. ADVANCING TIP MACH NUMBER

IAS(MPH)	M_A
75	.70
85	.71
95	.72
105	.74
115	.75
125	.76
135	.77

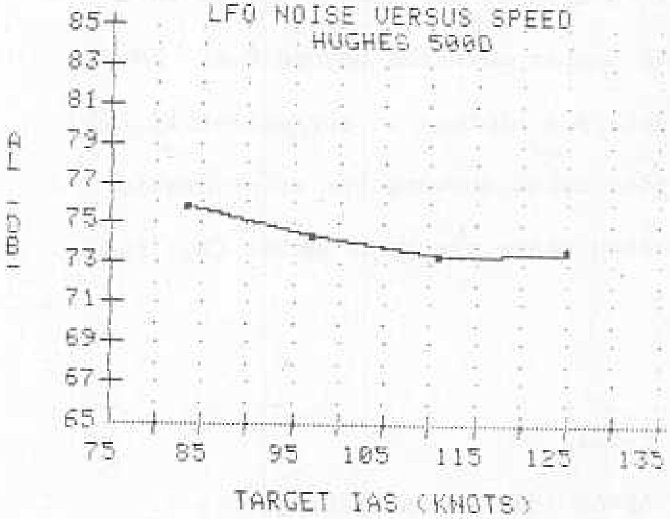


FIGURE 9.1

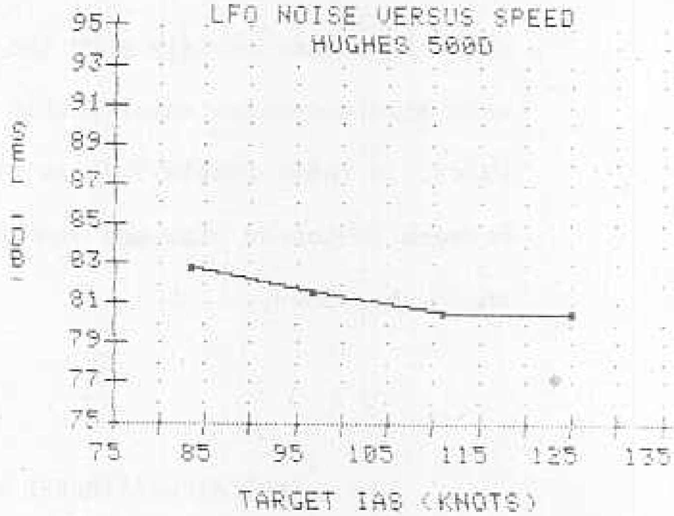


FIGURE 9.2

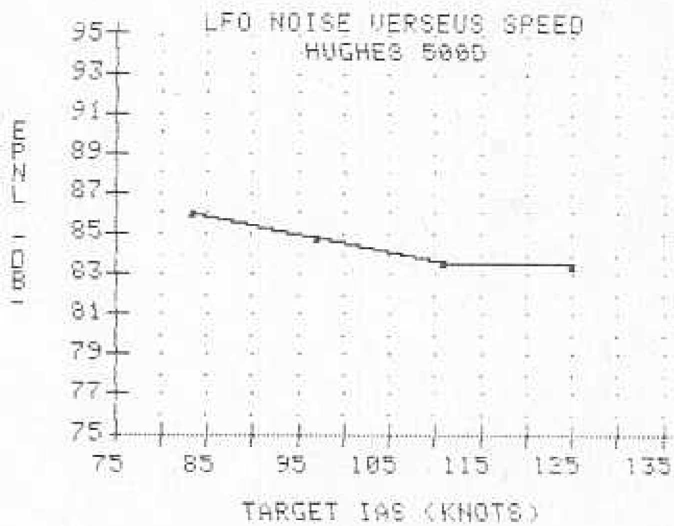


FIGURE 9.3

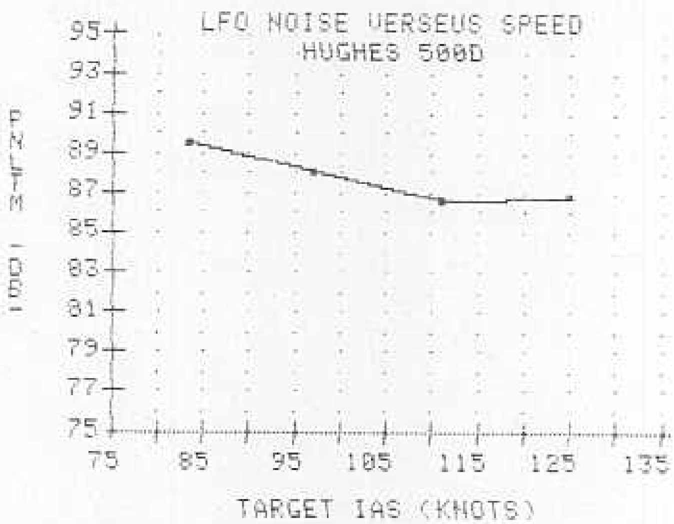


FIGURE 9.4

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 9.5 through 9.7 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 9.8, at the end of this section, shows the microphone positions and the hard and soft paths.

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 Hughes 500D (4-bladed tail rotor) acoustical radiation pattern for static operations.

Key points of interest include:

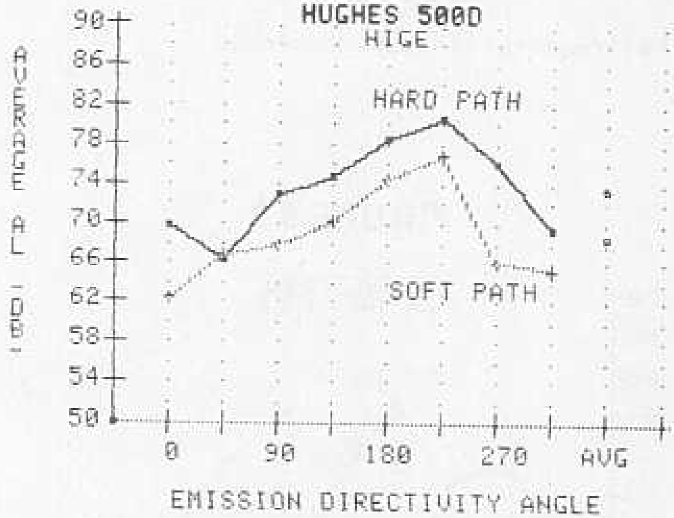
1. On the average the Ground Idle (GI) operation provides a 10dB benefit relative to the Flight Idle (FI) operation. The reduced RPM, GI mode epitomizes the concept of "Fly Neighborly" and is to be recommended for use in noise sensitive areas.

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.

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 specific heliport under consideration.

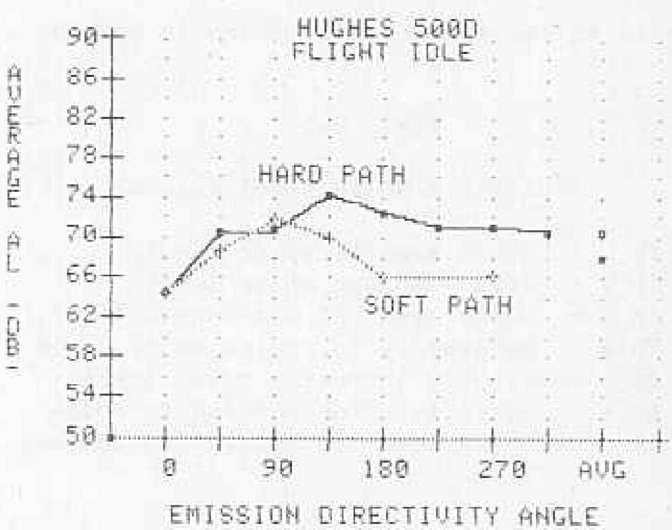
Hover in Ground Effect (HIGE) - The HIGE data plot, Figure 9.5, shows the marked left rear quadrant directivity maximum. The sound level values, in the upper to mid 70's for the hard path (at 500 feet), can in some situations (especially with long duration) present an environmental noise problem. The soft path levels range in the low to mid 70's, which may also be of concern in a quiet urban environment.

FIGURE 9.5



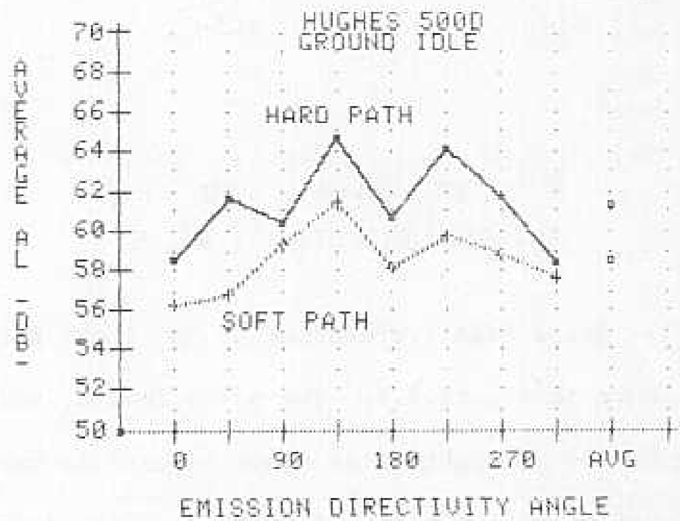
Flight Idle (FI) - Noise data (referenced to 500 feet) for the flight idle operations are shown in Figure 9.6. The noise levels, which vary from the mid 60's to the mid 70's, might raise minor concern in certain urban residential situations when duration is long. It is advisable to reduce RPM to GI whenever possible.

FIGURE 9.6



Ground Idle (GI) - Ground idle noise data (referenced to 500 feet) are presented in Figure 9.7. The sound levels fall in a range typically encountered in urban residential environments.

FIGURE 9.7



The table below (Table 9.2) 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. 9.

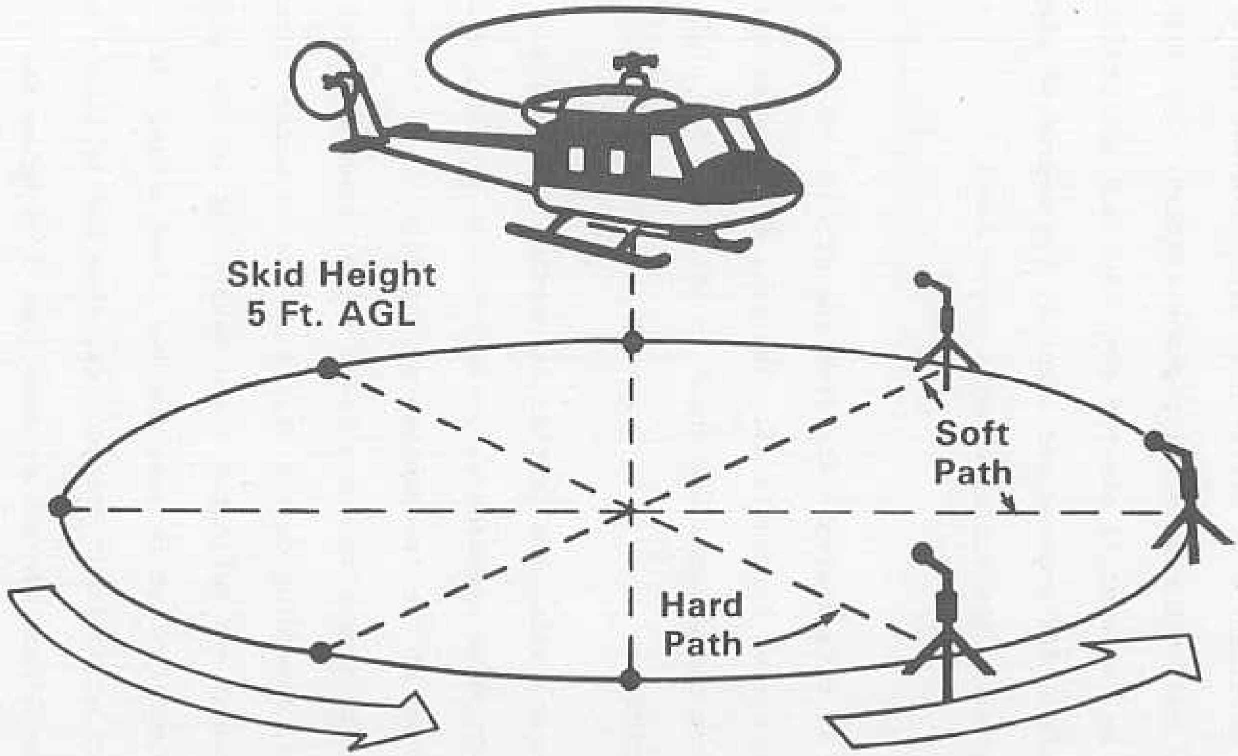
Table 9.2

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.

FIGURE 9.8

Helicopter Hover Noise Test



Helicopter Rotates in 45° Steps

8 Microphone Positions

9.3 Comparison of Measured Sound Levels: 4 Foot vs. Ground Microphones - This analysis addresses the comparability of noise levels measured at ground level and at 4 feet above the ground surface. The topic is discussed in the context of noise certification testing requirements. The analysis involves examination of differences between noise levels acquired for ground mounted and 4-ft mounted microphone systems. The objectives of this analysis are as follows: 1) observe the value and variability of ground/4-ft microphone differences and identify the degree of phase coherence and 2) examine the variation with operational configuration.

The data employed in this analysis are from the microphone site #1 magnetic recording system (Appendix A). The mean differences between the ground and four foot microphones are shown in Table 9.3 for eight different test series.

In conducting this analysis, our initial assumption was that the ground-mounted microphone experiences phase coherent pressure doubling (a reasonable assumption at the frequencies of interest). At the 4-foot microphone, one would expect to see a lower value, somewhere within the range of 0 to 3 dB, depending on the degree of random verses coherent phase between incident and reflected sound waves. It is also possible to experience phase cancellation between the two sound paths. If cancellation occurs at dominant frequencies, then one is likely to observe noise levels at the 4-foot microphone more than 3 dB below the ground microphone values. In fact, data presented in this section display significant canellation with instances of 4.6 dB (weighted metric) lower levels at the 4-foot microphone. Figure 9.9 provides a schematic of the various "difference regions" associated with different relationships between incident and reflected sound waves.

Discussion - It is argued that acquisition of data from ground-mounted microphones provides a cleaner spectrum, closer to the spectrum actually emitted by the helicopter--that is, not influened by a mixture of constructive and destructive ground reflections. Theoretically, one would be interested in correcting ground-based data to levels expected at 4 feet or vice versa in order to maintain equally stringent regulatory policy. In other words, to change a certificatino limit at a 4-ft microphone to fit a ground-based microphone test, one theoretically would have to increase the limit by an amount necessary to maintain equal stringency. Examination of the results in Table 9.3 show that most differences do fall between 3 and 5 dB. These results are consistent with theory and suggest that a degree of cancellation typiclly accompanies the 3 dB difference one would expect for random versus coherent phase relationships.

The variability in test results between operations modes displays no clear pattern. The variation in difference in values can be considered to reflect differences in the "acoustical angle" or the angle of incidence at the time of the maximum noise. These geometrical factors are also joined by differences in spectral content in influencing resulting sound level values. A narrow band analysis of the data would identify the specific frequencies where cancellation and reinforcement effects are present (and dominant) for various operational modes.

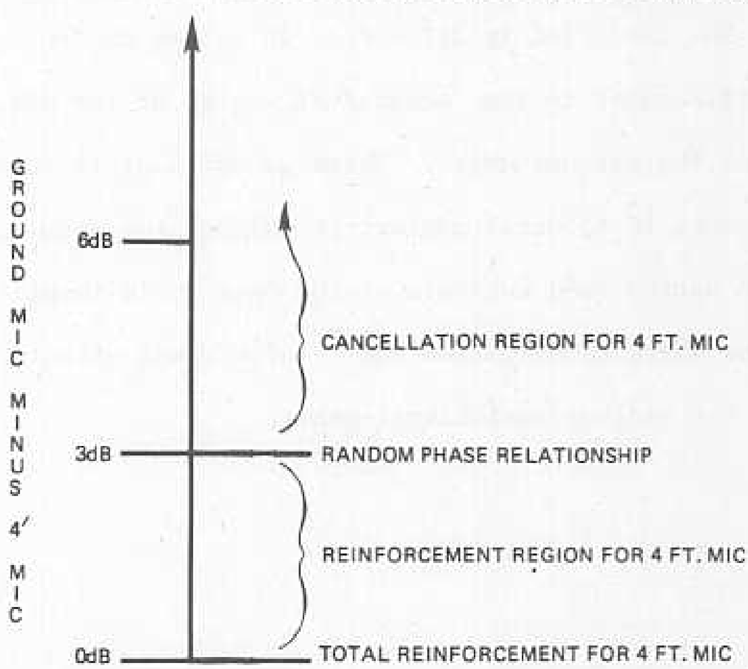
TABLE 9.3

TEST SERIES	OPERATION	SAMPLE SIZE	TARGET IAS (KTS)	DELTA DB + (GND MIC) MINUS (4FT.mic.)			
				SEL	AL	EPNL	PNLTM
A	500′ LFO	7	125	4.5	4.4	4.3	4.2
B	500′ LFO	5	111	3.5	3.8	3.3	3.9
C	500′ LFO	4	97	3.4	3.4	3.3	3.9
D	500′ LFO	4	83.5	3.4	3.1	3.2	4.4
E	1000′ LFO	3	125	3.8	4	3.6	4.2
F	6 DEG APP	6	62	4	3.5	3.3	2.5
G	6 DEG APP	5	72	3.8	2.9	3.1	2.2
H	6 DEG APP	5	52	3.6	3.3	3	2.7
I	ICAO T/O	6	62	3.6	3.9	2.3	2.2
J	9 DEG APP	4	62	3.6	3.7	3.6	3.8
K	STANDARD T/O	5	62	3.6	4.6	4.4	4.4
L	12 DEG APP	5	62	4.4	4	4.1	3.7
		*WEIGHTED AVERAGE		3.81	3.75	3.46	3.44

*NORMALIZED FOR SAMPLE SIZE

FIGURE 9.9

RELATIONSHIP BETWEEN INCIDENT AND REFLECTED SOUND WAVES



9.4 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.

9.4.1 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 arise 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) X 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 x LOG(Q x 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 isoceles 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 = 0.4 and a stable K(P) value of 7.0. Data have been plotted in Figure 9.10 and 9.11 which show the minor variation of both metrics with airspeed for the 6 degree approach and the level flyover operations 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)=7).

It is interesting to note that similar results were found for the Bell 222 helicopter, (Ref. 10) suggesting that different helicopter models will have similar values for K and Q. This implies that it would be unnecessary to develop unique constants for different helicopter models for use in implementing duration corrections. Caution is raised none the less to avoid any firm conclusions. The possibility prevails that this particular analytical technique lacks the sensitivity necessary to detect distance and air speed functionality.

9.4.2 Estimation of 10 dB Down Duration Time - In some cases, one does not have access to 10 dB down duration time (DURATION) information. A moderate to highly reliable technique for estimating DURATION for the Hughes 500D 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 micorphone sites 1,2 and 3 and has been presented in Table 9.4 along with the average DURATION expressed in seconds. A linear regression was performed on each data set in Table 9.4 and those results are also displayed in Table 9.4. Here one observes generally high correlation coefficients, in the range of 0.75 to 0.92. The regression equations relating DURATION with D/V are given as

Centerline center, Microphone Site 1:
$$T_{10} = [1.87 * (D/V)] + 2.2$$

Sideline South, Microphone Site 2:
$$T_{10} = [2.2 * (D/V)] + 2.2$$

Sideline North, Microphone Site 3:
$$T_{10} = [2.3 * (D/V)] - 2.3$$

It is interesting to note that each relationship has a similar slope but the sideline site equations exhibit intercept values 4 units (+2.2 to -2.3) or seconds, less than the centerline site equation. This demonstrates that sideline sites generally experience flyover time histories which are briefer and more 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 reasonably estimate the 10 dB down duration time.

Synthesis of Results - It is now possible to merge the results of Section 9.4.1 with the finding above in establishing a relationship between (D/V) and SEL and AL. Given the approximation

SEL = AL + (10 x LOG(0.45 x DURATION))

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

9.4.3 Relationship Between SEL minus AL and the Ratio D/V - 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 9.4.2. Table 9.5 provides a summary of data used in regression analyses for microphones 1, 2 and 3. The regression equations along with other statistical information is also provided in Table 9.5.

It is encouraging to note the strong correlations (coefficients greater than 0.85) 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 that similar regression equations resulted at all three microphone locations.

The reader is cautioned not to expect these relationships to necessarily hold for D/V ratios beyond the range explored in these analyses.

FIGURE 9.10

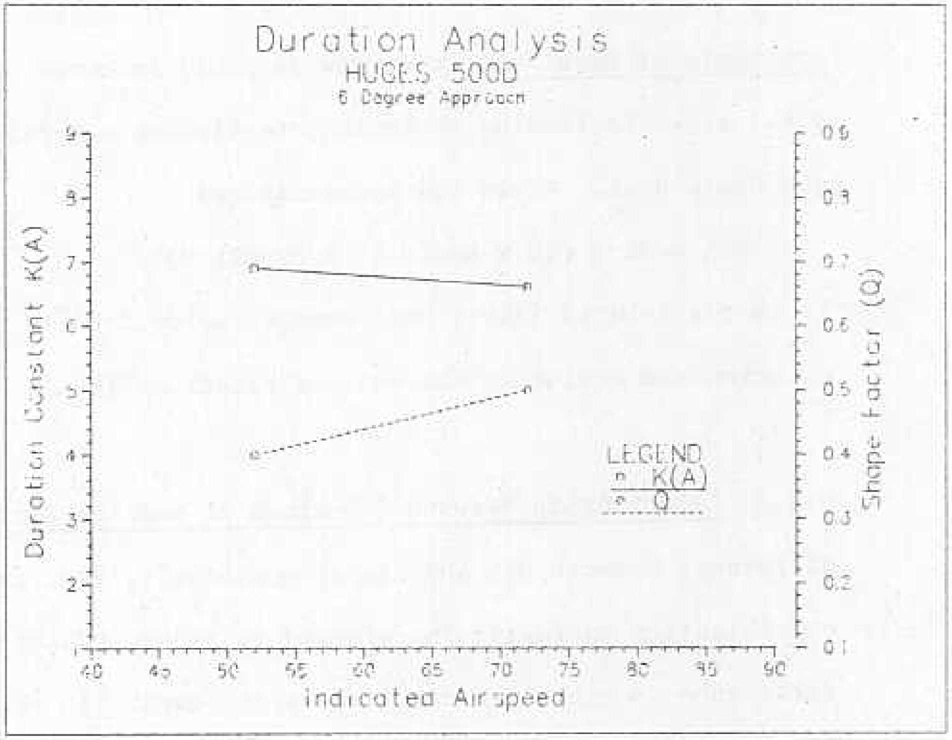


FIGURE 9.11

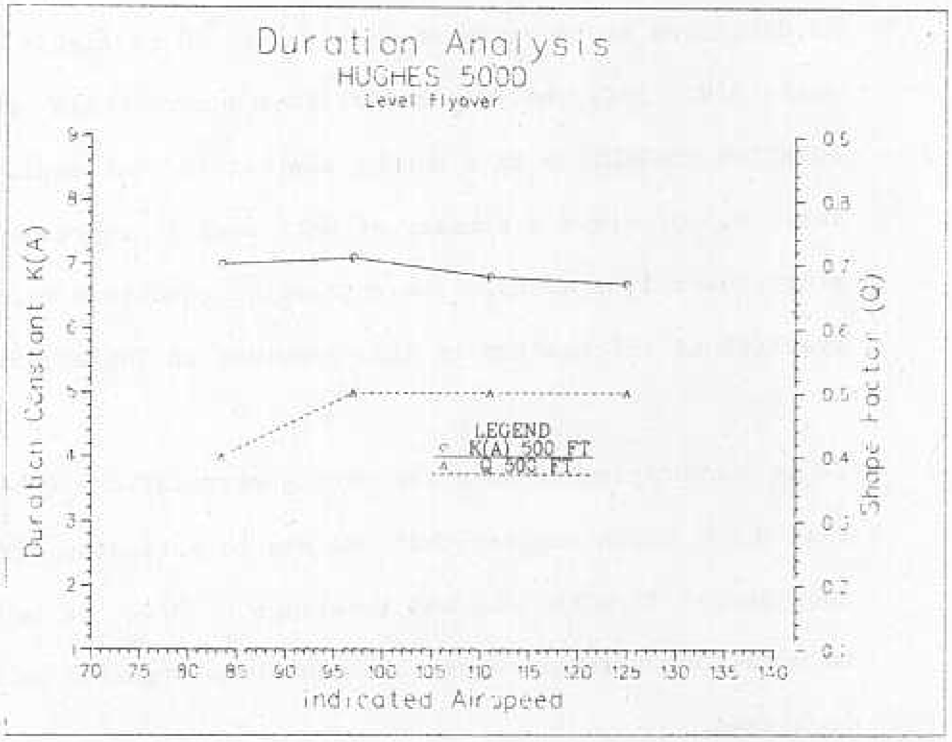


TABLE 9.4

DURATION (T-10) REGRESSION ON D/V

HELICOPTER: HUGHES 500D

SITE 1

TEST SERIES	COCKPIT PHOTO DATA V AVG	AVG SEL-ALm	AVG EST ALT	D/V
A	108	10.3	460.4	4.3
B	99	10.9	490.3	5
C	89	10.1	445.2	5
D	78	10.2	392.2	5
E	109	18.8	975.4	8.9
F	61	11.1	308.5	5.1
G	72	9.3	300.5	4.2
H	54	14.7	300.9	5.6
I	59	14.4	394.6	6.7
J	67	14	333.6	5
K	63	12.1	388.7	6.2
L	60	14	323.6	5.4

LINEAR REGRESSION

SITE #1

SLOPE	1.87
INTERCEPT	2.15
R SQ.	.74
R	.86
SAMPLE	12

SITE 2

A	108	12.3	674.1	6.2
B	99	12.8	694.7	7
C	89	14	666.4	7.5
D	78	17.7	629.9	8.1
E	109	18.5	1092.5	10
F	61	16.2	580.8	9.5
G	72	14.7	576.6	8
H	54	23.2	576.8	10.7
I	59	21.1	630.8	10.7
J	67	17.7	594.9	8.9
K	63	20.7	627.4	10
L	60	21.4	588.9	9.8

LINEAR REGRESSION

SITE #2

SLOPE	2.23
INTERCEPT	-2.24
R SQ.	.856
R	.92
SAMPLE	12

SITE 3

A	108	12.9	674.3	6.2
B	99	13.7	694.3	7
C	89	14.9	666.5	7.5
D	78	15.7	630.9	8.1
E	109	16.2	1092.1	10
F	61	17.2	576.7	9.5
G	72	18.8	572.8	8
H	54	29.2	572.8	10.6
I	59	20.9	619.6	10.5
J	67	18.4	588.1	8.8
K	63	18.6	616.5	9.8
L	60	22.4	581.5	9.7

LINEAR REGRESSION

SITE #3

SLOPE	2.33
INTERCEPT	-2.3
R SQ.	.57
R	.75
SAMPLE	12

TABLE 9.5

SEL-ALm REGRESSION ON D/V

HELICOPTER: HUGHES 500D

SITE 1

TEST SERIES	COCKPIT PHOTO DATA V AVG	AVG SEL-ALm	AVG EST ALT	D/V
A	108	6.8	460.4	4.3
B	99	7.1	490.3	5
C	89	7.1	445.2	5
D	78	7	392.2	5
E	109	9.2	975.4	8.9
F	61	7.1	308.5	5.1
G	72	6.4	300.5	4.2
H	54	8	300.9	5.6
I	59	8.5	394.6	6.7
J	67	8.1	333.6	5
K	63	8	388.7	6.2
L	60	7.8	323.6	5.4

LINEAR REGRESSION

SITE #1

SLOPE	.57
INTERCEPT	4.45
R SQ.	.80
R	.89
SAMPLE	12

SITE 2

A	108	7.6	674.1	6.2
B	99	7.8	694.7	7
C	89	8.1	666.4	7.5
D	78	8.6	629.9	8.1
E	109	9.5	1092.5	10
F	61	8.7	580.8	9.5
G	72	7.9	576.6	8
H	54	9.5	576.8	10.7
I	59	10.1	630.8	10.7
J	67	9.3	594.9	8.9
K	63	10	627.4	10
L	60	9.7	588.9	9.8

LINEAR REGRESSION

SITE #2

SLOPE	.56
INTERCEPT	3.96
R SQ.	.85
R	.92
SAMPLE	12

SITE 3

A	108	7.4	674.3	6.2
B	99	7.9	694.3	7
C	89	8.3	666.5	7.5
D	78	8.3	630.9	8.1
E	109	9.4	1092.1	10
F	61	8.7	576.7	9.5
G	72	8.8	572.8	8
H	54	10.3	572.8	10.6
I	59	9.8	619.6	10.5
J	67	9	588.1	8.8
K	63	9.5	616.5	9.8
L	60	9.2	581.5	9.7

LINEAR REGRESSION

SITE #3

SLOPE	.49
INTERCEPT	4.46
R SQ.	.75
R	.86
SAMPLE	12

9.5 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 9.6, 9.7, and 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 the 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 contributes 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. 10; Aerospatiale Dauphin, ref. 11). 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.

Table 9.6

HELICOPTER: HUGHES 500D

OPERATION: HOVER-IN-GROUND

	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	59.3	61.6	63.4	64.4	70.2	70	63.9	63.9	66.1	64.6
SOFT 2	62.4	66.9	67.8	70.3	74.6	76.9	66.1	65.1	71.3	68.8
DELTA dB	-3.1	-5.3	-4.4	-5.9	-4.4	-6.9	-2.2	-1.2	-5.2	-4.2

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

Table 9.7

HELICOPTER: HUGHES 500D

OPERATION: FLIGHT IDLE

SITE	DIRECTIVITY ANGLES (DEGREES) 0	45	90	135	180	225	270	315	Lav(360 DEGREE) ENERGY	ARITH.
	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ
SOFT 1H	56.9	56.6	63.6	62.5	61	58.5	57.8	57.1	60	59.2
SOFT 2	64.4	68.6	71.8	70	66	NA	66.3	NA	68.6	67.8
DELTA dB	-7.5	-12	-8.2	-7.5	-5	NA	-8.5	NA	-8.6	-8.6

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

Table 9.8

HELICOPTER: HUGHES 500D

OPERATION: GROUND IDLE

SITE	DIRECTIVITY ANGLES (DEGREES) 0	45	90	135	180	225	270	315	Lav(360 DEGREE) ENERGY	ARITH.
	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ
SOFT 1H	51.3	50.1	53	55.6	53.3	54.9	52.5	51.1	53.1	52.7
SOFT 2	56.3	56.8	59.4	61.4	58.1	59.7	58.8	57.6	58.8	58.5
DELTA dB	-5	-6.7	-6.4	-5.8	-4.8	-4.8	-6.3	-6.5	-5.7	-5.8

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

9.6 <u>Variation in Noise Levels With Airspeed for 6 and 9 Degree Approach Operations</u> - This section examines the variation in noise level for variations in approach angle. Data are presented for 6, 9 and 12 degree approaches. The appropriate series "As Measured" acoustical data contained in Appendix A, have been tabulated in Table 9.9 and plotted (corrected for the minor differences in altitude) in Figure 9.12 and 9.13. This analysis has two objectives: first, to evaluate further the realm of "Fly Neighborly" operating possibilities, and second, to consider whether or not it is reasonable to establish a range of approach operating conditions for noise certification testing.

<u>Discussion</u> - 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 9.14). As reported in reference 12, 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 9.12 and 9.13 portray the variation in noise level as the approach angle (rate of descent) changes for a constant airspeed of 62 knots. The potential benefit of using "Fly Neighborly" approach procedures is evident in the 3 dB differential between the 6 degree and 9 degree (as well as 12 degree) data.

Data were also presented for 6 degree approach operations at 52 and 72 knots. These data points represent changes in both rate-of-descent and airspeed. The observed noise levels for these operations were virtually the same as those for the 62 knot, 6 degree approach operation.

In the context of the "Fly Neighborly" program, it is worth acknowledging the potential tradeoff (and classic problem) of diminishing noise levels at one location while increasing noise levels at another. In this regard, it is considered important to further evaluate candidate "Fly Neighborly" operations at a matrix of locations in the vicinity of the overflight corridor.

A recent study conducted in France (ref. 13) 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 in any in-depth "Fly Neighborly" flight test.

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. 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 is clearly an important concern in commercial air-shuttle operations.

TABLE 9.9

VARIATIONS IN 6, 9 and 12 DEGREE
APPROACH OPERATIONS

	Microphone Site 5		Microphone Site 1		Microphone Site 4	
	$\overline{AL}$	$\overline{SEL}$	$\overline{AL}$	$\overline{SEL}$	$\overline{AL}$	$\overline{SEL}$
6°	82.6	90.0	80.9	87.9	79.2	87.1
9°	82.3	88.8	77.4	85.5	76.3	84.7
9°Adjusted*	82.8	89.1	77.9	85.8	76.8	85.0
12°	82.5	88.9	77.7	85.5	76.5	85.3
12°Adjusted*	83.0	89.2	78.2	85.8	77.0	85.6

*Average AL and SEL for 9 and 12 degree approaches adjusted for difference in altitude between 6 and 9, and 6 and 12 degree operations respectively.

FIGURE 9.12

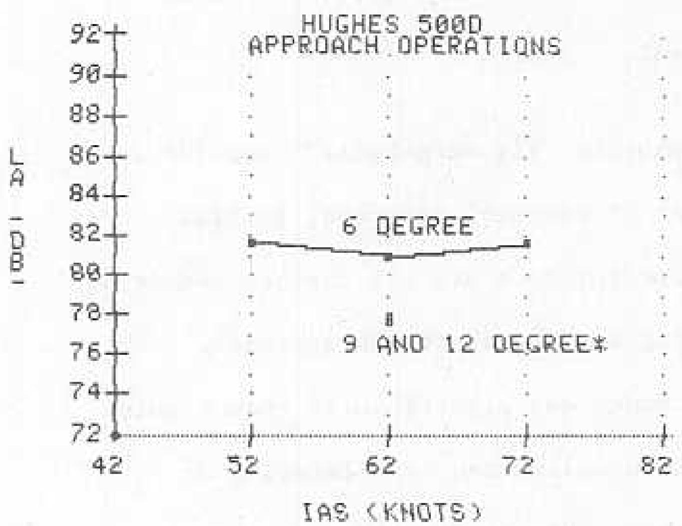
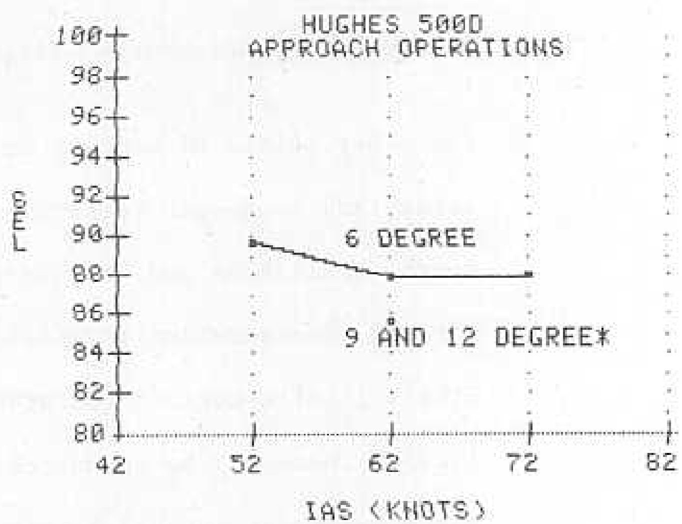
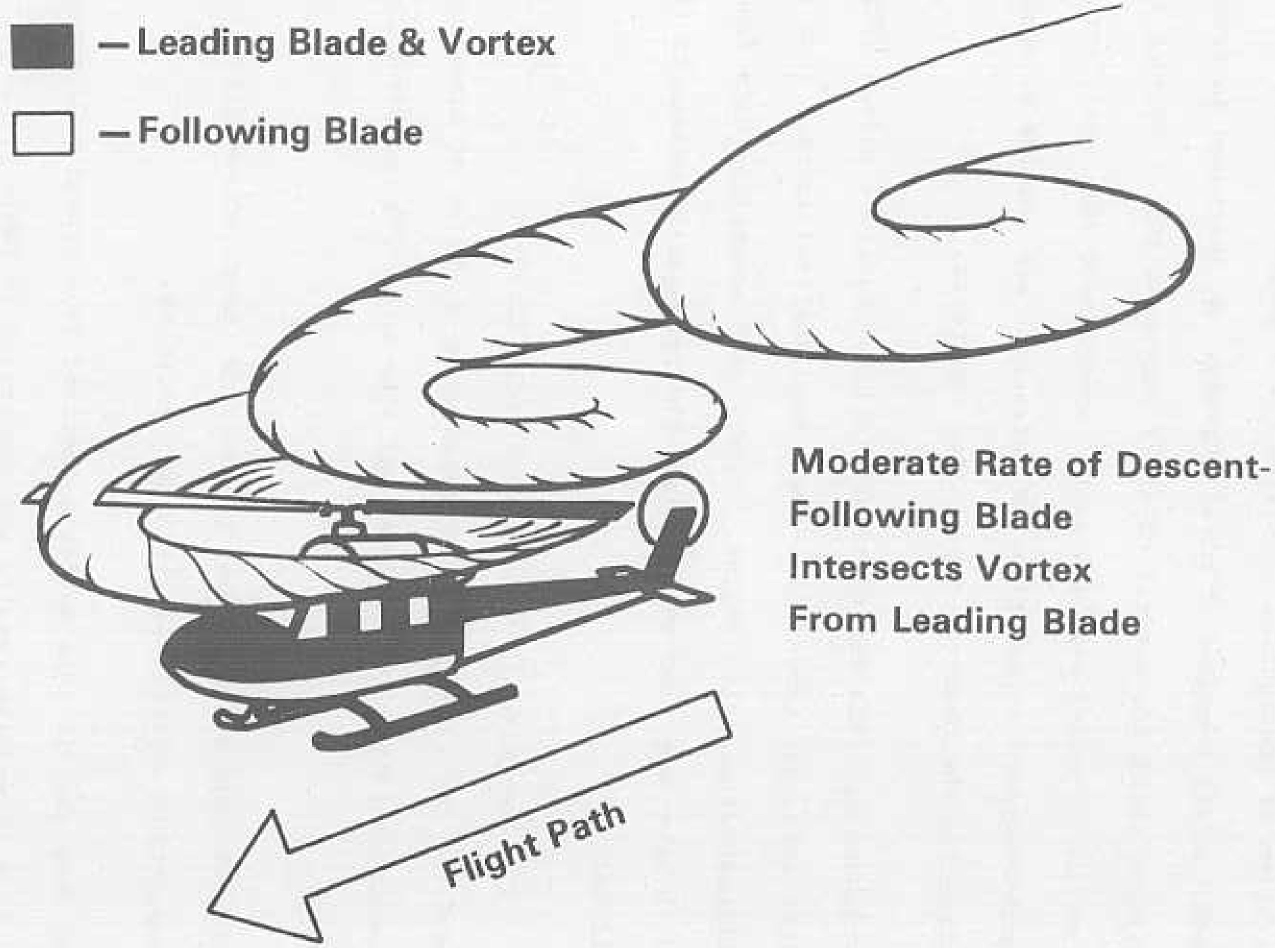


FIGURE 9.13



*9 and 12 degree adjusted data are coincident and appear as a single point.

Tip Vortex Interaction



9.7 Analysis of Ground-to-Ground Acoustical Propagation

9.7.1 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:

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

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 the results are summarized in Table 9.11.

Discussion - The results shown in Table 9.11 exhibit some minor variation from one operational mode to the next. The attenuation constants tend to agree well with results reported for the Aerospatiale Dauphin (ref. 11).

As noted in that report, the generalized relationship $\Delta dB = 25 \log (d1/d2)$ provides a working approximatin for calculating ground-to-ground diminution of A-weighted sound levels over nominally soft paths out to a distance of 1000 feet.

9.7.2 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 9.7.1) 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 temperature inversion (very low wind and very high humidity) 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 may have played a significant role in influencing the test results. Subsequent reports in this series will endeavor to further investigate hard path ground-to-ground propagation.

Table 9.10

DATA UTILIZED IN COMPUTING EMPIRICAL
PROPAGATION CONSTANTS (K)

HUGHES 500D

6-22-83

SITE 2 (SOFT SITE)

HIGE		FLT.IDLE		GND.IDLE	
M-0	68.90	N-0A	56.90	N-0B	62.10
M-315	66.30	N-315A	64.20	N-315B	57.40
M-270	66.60	N-270A	65.80	N-270B	58.40
M-225	76.70	N-225A	67.90	N-225B	61.30
M-180	77.10	N-180A	66.20	N-180B	58.60
M-135	70.20	N-135A	69.80	N-135B	61.40
M-90	68.20	N-90A	71.50	N-90B	59.80
M-45	67.00	N-45A	68.90	N-45B	58.10

SITE 4H (SOFT SITE)

HIGE		FLT.IDLE		GND.IDLE	
M-0	56.40	N-0A	47.00	N-0B	53.40
M-315	58.10	N-315A	56.90	N-315B	50.40
M-270	60.80	N-270A	58.80	N-270B	50.60
M-225	69.70	N-225A	58.90	N-225B	54.50
M-180	66.10	N-180A	59.90	N-180B	51.70
M-135	62.90	N-135A	64.30	N-135B	54.00
M-90	58.40	N-90A	62.20	N-90B	53.60
M-45	59.80	N-45A	63.10	N-45B	52.50

Table 9.11

HUGHES 500D

EMPIRICAL PROPOGATION CONSTANTS (K)

FOR SOFT SITES (4H+2)

EMISSION ANGLE	HIGE K	FLT.IDLE K	GND.IDLE K
0	41.67	33.00	29.00
315	27.33	24.33	23.33
270	19.33	23.33	26.00
225	23.33	30.00	22.67
180	36.67	21.00	23.00
135	24.33	18.33	24.67
90	32.67	31.00	20.67
45	24.00	19.33	18.67
AVERAGE	28.67 23.67*	25.04	23.50

* AVERAGE WITHOUT ANGLES 0, 180, AND 90.

9.8 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. 10, Ref. 11), 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.

Data have also been analyzed from the 500 and 1000 foot level flyover operations and the KP(AL) has been computed. 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 Table 9.12 and 9.13 and are summarized in Table 9.14. Results of the level flyover calculations are presented in Table 9.16. The level flyover and takeoff analyses are also accompanied by a tabulation of results from two previous reports (Tables 9.15 and 9.17).

Discussion - In the case of takeoff data (Table 9.14) one observes a propagation constant of 21.5, a value in good agreement with previous results for the Aerospatiale Dauphin 2 (see ref. 10). 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 9.16), one observes a value of approximately 23, also in good agreement with the Dauphin results. A comparison to the Bell 222 dta (ref. 10), however, does not fare so well (Bell 222, KP(AL) = 27.8). This discrepancy is likely associated with disparate source frequency content and different absoprtion characteristics on the various test days.

Table 9.18 provides a brief examination of propagation constants for the EPNL acoustical metric, used in noise certification. Calculations show a constant of approximately 16. This propagation constant is very close to the mean value observed for six helicopters (results summarized in Table 9.19) analyzed in other reports (Ref. 10, Ref. 11). The reader may consider computing propagation constants for other acoustical metrics as the need arises.

Table 9.12

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: ICAO TAKEOFF

MIC. 5-4

EVENT NO.	KP(AL)	KP(SEL)
I17	23.5	17.1
I18	20.2	15
I19	19.8	14.7
I20	21.6	11.5
I21	22.5	11.1
I22	18.7	11.1
AVERAGE	21.1	13.4
STD. DEV	1.79	2.54
90% C.I.	1.47	2.09

Table 9.13

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: STANDARD TAKEOFF

MIC. 5-4

EVENT NO.	KP(AL)	KP(SEL)
K27	19.5	13.1
K28	23.6	16.1
K29	18.6	14.5
K30	19.9	12.5
K31	25.9	14.2
K32	20	1.8
AVERAGE	21.2	12
STD. DEV	2.85	5.17
90% C.I.	2.35	4.26

Table 9.14

Summary Table of Propagation Constants
for Two Takeoff Operations

Operation	KP(AL)
ICAO Takeoff	21.1
Standard Takeoff	21.2
Average	21.15

Table 9.15

Summary Table for Takeoff Operation--AL Metric

Helicopter		Propagation Constant (K)
Bell 222		NA
Aeropsatiale Dauphin 2		20.67
Hughes 500D		21.15
	Average	20.91

Table 9.16

HUGHES 500D

LEVEL FLYOVER PROPAGATION--AL

OPERATION		MIC 5	MIC 1	MIC 4	AL WEIGHTED AVERAGE
	N=	7	7	7	
500′ (0.9Vh)	AVG AL=	74.6	73.7	74.2	74.17
	STD DEV=	.8	.8	1	
	N=	2	3	3	
1000′ (0.9Vh)	AVG AL=	67.7	67.5	67.1	67.40
	STD DEV=	.7	.2	.1	

K= ΔdB / LOG(1000/500) ΔdB= 6.77

K= 6.77/.3

K= 22.56

TABLE 9.17

Summary for Level Flyover Operation--AL Metric

Helicopter		Propagation Constant (K)
Bell 222		27.8
Aerospatiale Dauphin 2		22.7
Hughes 500D		23.07
	Average	24.52

Table 9.18
HUGHES 500D

LEVEL FLYOVER PROPAGATION--EPNL

OPERATION		MIC 5	MIC 1	MIC 4	EPNL WEIGHTED AVERAGE
	N=	7	7	7	
500' (0.9Vh)	AVG EPNL=	84.2	83.4	83.8	83.80
	STD DEV=	.5	.7	.7	
	N=	2	3	3	
1000' (0.9Vh)	AVG EPNL=	79.1	79.2	78.7	78.99
	STD DEV=	.7	.5	.7	

K= ΔdB / LOG(1000/500) ΔdB= 4.81

K= 4.81/.3

K= 16.04

Table 9.19

Summary Table for Level Flyover Operation
EPNL Metric

Helicopter	Propagation Constant (K)
Bell 222	18.78
Aerospatiale Dauphin 2	19.67
Hughes 500D	16.04
Average	18.16

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HUGHES 500D/E

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. 1

- Appendix No. — A.
- Helicopter No. & Microphone Location — 1-1.
- Page No. of Group — 1

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:
	$Q = (10^{0.1(SEL-ALm)} / (DUR(A))$
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.6-1.1

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 1 CENTERLINE - CENTER JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
6 DEGREE APPROACH -- TARGET IAS 62KTS. (ICAO)													
F1	88.6	81.0	7.6	7.0	0.5	90.2	91.6	92.3	7.5	86.6	12.5	11.0	0.7
F2	86.6	79.2	7.3	6.7	0.4	88.9	90.4	91.5	6.7	86.5	12.5	13.0	1.1
F3	89.8	83.0	6.8	6.6	0.5	91.6	93.6	94.7	7.0	87.8	10.5	9.5	1.1
F4	88.4	80.6	7.9	7.1	0.5	90.2	92.1	92.9	6.7	87.3	13.0	12.0	0.9
F5	85.9	79.0	6.9	7.0	0.5	88.3	90.7	91.5	6.8	86.3	9.5	10.0	0.8
F6	88.2	82.3	5.8	6.3	0.5	89.9	92.9	93.6	6.6	87.6	8.5	9.0	0.6
Avg.	87.9	80.9	7.1	6.8	0.5	89.8	91.9	92.8	6.9	87.0	11.1	10.7	0.9
Std Dv	1.4	1.6	0.7	0.3	0.0	1.1	1.3	1.3	0.3	0.6	1.9	1.5	0.2
90% CI	1.2	1.3	0.6	0.2	0.0	0.9	1.0	1.0	0.3	0.5	1.5	1.3	0.1
TAKEOFF -- TARGET IAS 62KTS. (ICAO)													
I17	83.4	75.3	8.1	7.4	0.5	85.7	86.3	87.6	6.9	81.6	12.5	14.5	1.3
I18	83.3	75.4	7.9	7.2	0.5	85.5	86.3	87.5	6.9	81.9	12.5	14.0	1.2
I19	83.0	74.1	8.9	7.6	0.5	85.0	84.8	85.9	7.6	80.4	14.5	16.0	1.3
I20	84.2	75.4	8.8	7.6	0.5	86.3	85.9	87.2	7.7	81.8	14.5	15.5	1.2
I21	83.5	75.1	8.4	7.0	0.4	85.5	86.2	87.4	7.1	81.9	16.0	14.0	1.1
I22	83.7	74.7	9.0	7.4	0.5	85.8	85.6	87.0	7.2	81.4	16.5	17.0	1.4
Avg.	83.5	75.0	8.5	7.4	0.5	85.6	85.9	87.1	7.2	81.5	14.4	15.2	1.3
Std Dv	0.4	0.5	0.4	0.2	0.0	0.4	0.6	0.6	0.3	0.6	1.7	1.2	0.1
90% CI	0.3	0.4	0.4	0.2	0.0	0.4	0.5	0.5	0.3	0.5	1.4	1.0	0.1
TAKEOFF -- STANDARD (SEE TEXT)													
K27	83.7	76.9	6.7	6.9	0.5	86.0	88.4	89.3	7.0	83.8	9.5	9.0	0.9
K28	84.0	76.2	7.8	7.1	0.5	86.1	87.4	88.5	6.9	82.8	12.5	13.0	1.1
K30	83.3	75.1	8.2	7.6	0.6	85.3	85.5	86.7	7.7	81.2	12.0	13.0	1.3
K31	84.1	76.3	7.9	7.4	0.5	86.4	87.5	88.6	7.2	82.7	11.5	12.0	1.1
K32	83.5	74.1	9.4	8.0	0.6	85.4	84.7	85.9	8.1	80.5	15.0	15.0	1.1
Avg.	83.7	75.7	8.0	7.4	0.5	85.8	86.7	87.8	7.4	82.2	12.1	12.4	1.1
Std Dv	0.3	1.1	1.0	0.4	0.0	0.5	1.5	1.4	0.5	1.3	2.0	2.2	0.1
90% CI	0.3	1.1	0.9	0.4	0.0	0.4	1.4	1.4	0.5	1.3	1.9	2.1	0.1

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

TABLE NO. A.6-1.2

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 1 CENTERLINE - CENTER JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 125 KTS.													
A38	81.7	75.2	6.5	6.5	0.4	84.5	86.7	88.1	6.3	83.9	10.0	10.5	1.4
A39	80.8	73.2	7.6	6.8	0.4	83.5	85.0	86.1	7.2	83.4	13.0	11.0	1.2
A40	80.5	73.6	6.9	6.7	0.5	83.6	85.5	86.8	6.3	83.9	10.5	12.0	1.2
A41	80.9	74.3	6.6	6.9	0.5	83.9	86.5	87.5	6.8	84.4	9.0	9.0	1.0
A42	79.7	73.1	6.7	6.7	0.5	82.6	85.1	86.4	6.5	83.7	10.0	9.0	1.3
A43	80.0	73.1	7.0	6.8	0.5	83.0	85.3	86.3	6.7	83.5	10.5	10.0	0.9
A44	79.9	73.6	6.3	6.6	0.5	82.8	85.8	86.5	6.6	84.2	9.0	9.0	1.1
Avg.	80.5	73.7	6.8	6.7	0.5	83.4	85.7	86.8	6.6	83.8	10.3	10.1	1.2
Std Dv	0.7	0.8	0.4	0.1	0.0	0.7	0.7	0.7	0.3	0.4	1.3	1.2	0.1
90% CI	0.5	0.6	0.3	0.1	0.0	0.5	0.5	0.5	0.2	0.3	1.0	0.9	0.1
500 FT. FLYOVER -- TARGET IAS 111KTS.													
B45	81.0	74.4	6.6	6.6	0.5	84.1	86.5	87.7	6.4	84.4	10.0	10.0	1.2
B46	79.7	72.7	7.0	6.7	0.5	82.4	84.3	85.5	6.6	83.4	11.0	11.0	1.2
B47	80.7	73.7	7.0	7.0	0.5	83.9	85.7	86.9	7.0	84.5	10.0	10.0	1.2
B48	80.1	73.0	7.1	6.8	0.5	83.0	85.0	86.3	6.6	83.9	11.0	10.5	1.2
B49	81.1	73.4	7.6	7.0	0.5	84.2	85.6	86.8	6.9	84.3	12.5	12.0	1.2
Avg.	80.5	73.4	7.1	6.8	0.5	83.5	85.4	86.6	6.7	84.1	10.9	10.7	1.2
Std Dv	0.6	0.7	0.4	0.2	0.0	0.8	0.8	0.8	0.2	0.4	1.0	0.8	0.0
90% CI	0.6	0.6	0.4	0.2	0.0	0.8	0.8	0.8	0.2	0.4	1.0	0.8	0.0
500 FT. FLYOVER -- TARGET IAS 97KTS.													
C50	80.9	73.5	7.4	7.2	0.5	84.0	85.7	87.1	6.9	83.8	10.5	10.0	1.5
C51	80.9	73.4	7.5	7.2	0.5	84.0	85.4	86.4	7.4	83.4	11.0	10.5	1.0
C52	80.1	72.5	7.5	7.1	0.5	83.2	84.9	86.1	6.9	82.7	11.5	10.5	1.1
C53	84.0	78.1	6.0	6.8	0.5	87.6	91.2	92.4	6.2	87.0	7.5	7.0	1.2
Avg.	81.5	74.4	7.1	7.1	0.5	84.7	86.8	88.0	6.9	84.2	10.1	9.5	1.2
Std Dv	1.7	2.5	0.8	0.2	0.0	2.0	3.0	2.9	0.5	1.9	1.8	1.7	0.2
90% CI	2.1	2.9	0.9	0.2	0.0	2.4	3.5	3.5	0.6	2.3	2.1	2.0	0.3
500 FT. FLYOVER -- TARGET IAS 83.5 KTS.													
D54	82.0	75.6	6.4	6.5	0.5	85.3	88.1	89.5	6.4	84.7	9.5	8.0	1.4
D55	82.9	76.5	6.5	6.8	0.5	86.2	88.9	90.0	6.7	84.3	9.0	8.5	1.1
D56	81.4	73.8	7.6	7.0	0.5	84.3	86.1	87.3	6.7	84.2	12.0	11.0	1.2
D57	84.8	77.1	7.6	7.5	0.6	88.0	90.1	91.3	7.0	85.1	10.5	9.0	1.1
Avg.	82.8	75.8	7.0	7.0	0.5	85.9	88.3	89.5	6.7	84.6	10.2	9.1	1.2
Std Dv	1.5	1.4	0.7	0.4	0.0	1.6	1.7	1.7	0.2	0.4	1.3	1.3	0.2
90% CI	1.7	1.7	0.8	0.5	0.0	1.8	2.0	1.9	0.3	0.5	1.6	1.5	0.2
1000 FT. FLYOVER -- TARGET IAS 125KTS.													
E58	77.0	67.3	9.7	7.4	0.5	79.7	78.9	79.9	7.4	78.4	20.5	21.0	1.2
E59	76.3	67.6	8.7	7.0	0.4	78.7	78.8	79.7	7.1	78.1	17.5	18.5	0.9
E60	76.8	67.6	9.2	7.3	0.4	79.1	78.8	79.9	7.4	78.1	18.5	18.0	1.0
Avg.	76.7	67.5	9.2	7.2	0.4	79.2	78.8	79.8	7.3	78.2	18.8	19.2	1.0
Std Dv	0.4	0.2	0.5	0.2	0.0	0.5	0.0	0.1	0.2	0.2	1.5	1.6	0.2
90% CI	0.6	0.3	0.9	0.4	0.0	0.8	0.1	0.2	0.3	0.3	2.6	2.7	0.3

TABLE NO. A.6-1.3

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 1 CENTERLINE - CENTER JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
6 DEGREE APPROACH -- TARGET IAS 72KTS.													
G7	89.0	84.1	4.9	5.8	0.4	90.8	94.6	95.5	6.1	90.0	7.0	7.5	0.9
G8	87.6	80.8	6.8	6.8	0.5	89.9	92.7	93.6	6.4	88.2	10.0	9.5	0.9
G9	85.8	79.3	6.5	6.5	0.4	88.1	91.3	92.3	6.0	87.1	10.0	9.5	1.0
G10	89.3	82.2	7.2	7.2	0.5	91.2	93.3	94.1	7.0	89.4	10.0	10.5	0.7
G11	88.3	81.7	6.7	6.8	0.5	90.3	92.7	93.9	6.8	88.2	9.5	9.0	1.2
Avg.	88.0	81.6	6.4	6.6	0.5	90.1	92.9	93.9	6.5	88.6	9.3	9.2	1.0
Std Dv	1.4	1.8	0.9	0.5	0.0	1.2	1.2	1.2	0.4	1.1	1.3	1.1	0.2
90% CI	1.4	1.7	0.8	0.5	0.0	1.1	1.2	1.1	0.4	1.1	1.2	1.0	0.2
6 DEGREE APPROACH -- TARGET IAS 52KTS.													
H12	87.9	80.8	7.0	6.5	0.4	90.4	92.0	93.2	6.7	87.3	12.0	12.0	1.1
H13	91.4	83.3	8.1	6.9	0.4	93.0	94.0	94.9	7.1	89.5	15.0	14.0	0.9
H14	88.5	80.0	8.5	7.0	0.4	90.2	91.0	91.8	6.9	86.5	16.5	16.5	0.9
H15	89.0	79.9	9.1	7.3	0.5	91.1	90.4	91.3	7.8	86.4	18.0	18.0	0.9
H16	91.3	84.0	7.3	6.7	0.4	92.4	94.5	95.7	6.5	89.0	12.0	11.0	1.2
Avg.	89.6	81.6	8.0	6.9	0.4	91.4	92.4	93.4	7.0	87.7	14.7	14.3	1.0
Std Dv	1.6	1.9	0.9	0.3	0.0	1.2	1.8	1.9	0.5	1.5	2.7	2.9	0.2
90% CI	1.6	1.8	0.8	0.3	0.0	1.2	1.7	1.8	0.5	1.4	2.6	2.8	0.2
9 DEGREE APPROACH -- TARGET IAS 62KTS.													
J23	84.5	76.4	8.1	7.3	0.5	86.4	87.9	88.9	7.0	83.9	12.5	12.0	1.0
J24	86.2	77.9	8.3	6.9	0.4	88.2	88.9	90.0	6.7	84.6	16.0	16.5	1.1
J25	85.4	77.3	8.1	7.1	0.5	87.1	88.1	89.2	7.0	84.6	14.0	13.5	1.1
J26	85.7	78.0	7.8	6.9	0.4	87.7	89.2	90.3	6.7	84.1	13.5	13.0	1.1
Avg.	85.5	77.4	8.1	7.1	0.5	87.4	88.5	89.6	6.8	84.3	14.0	13.7	1.1
Std Dv	0.7	0.7	0.2	0.2	0.0	0.8	0.6	0.7	0.2	0.4	1.5	1.9	0.1
90% CI	0.8	0.8	0.3	0.2	0.0	0.9	0.7	0.8	0.2	0.4	1.7	2.3	0.1
12 DEGREE APPROACH -- TARGET IAS 62KTS.													
L33	84.9	77.2	7.7	7.1	0.5	87.0	88.4	89.1	6.9	84.3	12.0	14.0	0.8
L34	84.9	76.6	8.3	6.7	0.4	86.5	87.7	88.5	7.6	84.5	17.5	11.5	0.8
L35	83.8	76.7	7.1	6.8	0.5	85.7	87.6	88.5	6.9	84.7	11.0	11.0	0.9
L36	89.1	81.7	7.4	6.6	0.4	91.0	92.8	93.8	6.5	87.3	13.0	13.0	1.0
L37	84.9	76.1	8.8	7.2	0.5	86.8	87.0	88.1	7.3	84.0	16.5	15.5	1.1
Avg.	85.5	77.7	7.8	6.9	0.4	87.4	88.7	89.6	7.0	85.0	14.0	13.0	0.9
Std Dv	2.1	2.3	0.7	0.3	0.0	2.1	2.4	2.4	0.4	1.3	2.9	1.8	0.1
90% CI	2.0	2.2	0.7	0.3	0.0	2.0	2.2	2.3	0.4	1.3	2.7	1.8	0.1

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

TABLE NO. A.6-1G.1

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 1G CENTERLINE - CENTER JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
6 DEGREE APPROACH -- TARGET IAS 62KTS. (ICAO)													
F1	92.7	84.9	7.8	7.3	0.5	93.7	94.8	95.8	7.4	90.2	11.5	11.5	1.0
F2	90.0	81.7	8.3	7.0	0.4	91.4	91.8	92.9	7.2	88.6	15.0	15.0	1.3
F3	94.0	86.7	7.3	7.0	0.5	95.0	96.0	97.2	7.4	90.7	11.0	11.0	1.2
F4	92.7	84.9	7.9	7.1	0.5	94.0	94.4	95.9	7.1	90.4	13.0	13.5	1.6
F5	89.8	82.3	7.5	7.0	0.5	91.5	92.6	93.6	7.3	89.1	12.0	12.0	1.5
F6	92.0	85.6	6.5	6.5	0.4	93.1	95.7	96.3	6.7	91.1	10.0	10.5	0.6
Avg.	91.9	84.4	7.5	7.0	0.5	93.1	94.2	95.3	7.2	90.0	12.1	12.2	1.2
Std Dv	1.7	1.9	0.6	0.3	0.0	1.4	1.7	1.7	0.3	1.0	1.7	1.7	0.4
90% CI	1.4	1.6	0.5	0.2	0.0	1.2	1.4	1.4	0.2	0.8	1.4	1.4	0.3
TAKEOFF -- TARGET IAS 62KTS. (ICAO)													
I17	87.5	78.9	8.7	7.5	0.5	88.4	88.2	89.6	7.5	83.5	14.5	15.0	1.4
I18	86.8	79.1	7.8	7.0	0.5	87.6	88.7	89.5	7.1	84.4	13.0	14.0	0.8
I19	86.7	77.7	8.9	7.6	0.5	87.2	87.2	87.9	7.7	82.8	15.0	16.5	0.7
I20	87.2	79.8	7.3	6.7	0.4	87.9	89.0	89.9	6.9	84.6	12.5	14.0	0.8
I21	87.5	79.6	7.8	6.8	0.4	88.2	89.4	90.3	6.8	85.0	14.0	15.0	0.9
I22	87.2	78.3	8.9	7.5	0.5	88.0	88.2	88.9	7.4	83.5	15.0	16.5	0.7
Avg.	87.1	78.9	8.2	7.2	0.5	87.9	88.5	89.3	7.2	84.0	14.0	15.2	0.9
Std Dv	0.3	0.8	0.7	0.4	0.0	0.4	0.8	0.9	0.4	0.8	1.0	1.1	0.3
90% CI	0.3	0.6	0.6	0.3	0.0	0.4	0.7	0.7	0.3	0.7	0.9	0.9	0.2
TAKEOFF -- STANDARD (SEE TEXT)													
K27	88.1	81.4	6.7	6.7	0.5	90.3	92.4	93.3	6.9	87.5	10.0	10.5	0.9
K28	88.5	80.6	7.9	7.2	0.5	90.4	91.5	92.5	7.1	86.3	12.5	13.0	1.0
K30	88.6	79.9	8.7	7.9	0.6	90.4	90.5	91.7	7.6	85.4	13.0	13.5	1.4
K31	88.5	80.6	8.0	7.5	0.5	90.5	91.5	92.7	7.3	86.1	11.5	12.0	1.2
K32	87.9	79.2	8.7	7.5	0.5	89.6	89.6	90.6	7.6	84.4	14.5	15.5	1.4
Avg.	88.3	80.3	8.0	7.4	0.5	90.2	91.1	92.2	7.3	85.9	12.3	12.9	1.2
Std Dv	0.3	0.8	0.8	0.4	0.0	0.3	1.1	1.0	0.3	1.1	1.7	1.9	0.2
90% CI	0.3	0.8	0.8	0.4	0.0	0.3	1.0	1.0	0.3	1.1	1.6	1.8	0.2

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

DOT/TSC
11/16/83

TABLE NO. A.6-1G.2

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 1G CENTERLINE-CENTER (FLUSH) JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 125KTS.													
A38	86.3	80.1	6.2	6.5	0.5	88.9	91.6	92.6	6.5	88.5	9.0	9.5	1.0
A39	85.1	77.8	7.3	7.0	0.5	87.7	89.4	90.6	6.7	87.9	11.0	11.5	1.2
A40	85.0	77.5	7.5	7.3	0.5	87.7	89.7	90.8	6.9	87.8	10.5	10.0	1.1
A41	85.3	78.3	7.0	7.2	0.5	88.0	90.4	91.2	7.0	88.4	9.5	9.5	0.8
A42	84.3	77.3	7.1	7.2	0.5	87.0	89.2	90.3	6.8	88.0	9.5	9.5	1.1
A43	84.7	78.0	6.7	6.9	0.5	87.5	90.1	91.1	6.6	88.0	9.5	9.5	1.0
A44	84.4	77.6	6.8	6.8	0.5	87.0	89.5	90.4	6.6	87.6	10.0	10.0	0.9
Avg.	85.0	78.1	7.0	7.0	0.5	87.7	90.0	91.0	6.7	88.0	9.9	9.9	1.0
Std Dv	0.7	1.0	0.4	0.3	0.0	0.7	0.8	0.8	0.2	0.3	0.7	0.7	0.1
90% CI	0.5	0.7	0.3	0.2	0.0	0.5	0.6	0.6	0.1	0.2	0.5	0.5	0.1
500 FT. FLYOVER -- TARGET IAS 111KTS.													
B45	84.6	78.0	6.6	6.5	0.4	87.6	90.1	91.5	6.2	87.6	10.5	9.5	1.4
B46	83.5	76.6	6.9	6.7	0.5	85.9	88.2	89.6	6.3	86.5	10.5	10.5	1.4
B47	84.1	77.1	7.1	6.9	0.5	87.1	89.4	90.7	6.4	87.8	10.5	10.0	1.3
B48	83.5	76.8	6.8	7.1	0.5	86.4	88.3	89.9	6.6	86.9	9.0	9.5	1.8
B49	84.5	77.4	7.1	6.8	0.5	87.2	89.3	90.6	6.5	87.7	11.0	10.0	1.3
Avg.	84.0	77.2	6.9	6.8	0.5	86.8	89.1	90.5	6.4	87.3	10.3	9.9	1.4
Std Dv	0.5	0.6	0.2	0.2	0.0	0.7	0.8	0.7	0.2	0.6	0.8	0.4	0.2
90% CI	0.5	0.5	0.2	0.2	0.0	0.6	0.7	0.7	0.1	0.5	0.7	0.4	0.2
500 FT. FLYOVER -- TARGET IAS 97KTS.													
C50	83.8	76.7	7.1	6.9	0.5	87.0	88.8	90.9	6.5	87.0	10.5	9.0	2.1
C51	84.6	76.7	7.8	7.3	0.5	87.5	88.8	90.6	6.9	87.3	12.0	10.0	1.8
C52	83.9	76.6	7.3	7.2	0.5	86.8	88.7	90.6	6.4	86.1	10.5	9.5	1.9
C53	87.2	81.2	6.0	6.8	0.5	90.6	93.7	95.4	6.1	90.3	7.5	7.0	1.6
Avg.	84.9	77.8	7.1	7.1	0.5	88.0	90.0	91.9	6.5	87.7	10.1	8.9	1.9
Std Dv	1.6	2.3	0.8	0.2	0.0	1.7	2.5	2.3	0.3	1.8	1.9	1.3	0.2
90% CI	1.9	2.7	0.9	0.2	0.0	2.1	2.9	2.8	0.3	2.2	2.2	1.5	0.2
500 FT. FLYOVER -- TARGET IAS 83.5KTS.													
D54	85.2	78.9	6.3	6.8	0.5	88.4	90.5	92.7	6.4	88.4	8.5	7.5	2.2
D55	86.6	79.7	6.9	6.8	0.5	89.6	91.6	93.4	6.4	88.3	10.5	9.5	1.9
D56	84.8	77.0	7.8	7.2	0.5	87.6	88.9	90.8	6.6	87.7	12.0	10.5	1.9
D57	88.3	80.2	8.0	7.9	0.6	90.8	92.2	93.9	7.0	89.3	10.5	10.0	1.8
Avg.	86.2	78.9	7.3	7.2	0.5	89.1	90.8	92.7	6.6	88.4	10.4	9.4	1.9
Std Dv	1.6	1.4	0.8	0.5	0.1	1.4	1.4	1.4	0.3	0.7	1.4	1.3	0.2
90% CI	1.9	1.7	0.9	0.6	0.1	1.7	1.7	1.6	0.3	0.8	1.7	1.5	0.2
1000 FT. FLYOVER -- TARGET IAS 125KTS.													
E58	80.8	71.3	9.5	7.7	0.5	83.2	82.8	84.3	7.2	82.4	17.5	17.5	1.5
E59	79.9	71.5	8.4	7.1	0.5	82.2	82.4	83.5	7.1	81.8	15.0	16.5	1.5
E60	80.8	71.7	9.2	7.3	0.5	83.1	83.0	84.2	7.3	82.3	18.0	16.5	1.2
Avg.	80.5	71.5	9.0	7.4	0.5	82.8	82.7	84.0	7.2	82.2	16.8	16.8	1.4
Std Dv	0.5	0.2	0.6	0.3	0.0	0.6	0.3	0.4	0.1	0.3	1.6	0.6	0.2
90% CI	0.9	0.3	1.0	0.5	0.1	1.0	0.5	0.7	0.2	0.6	2.7	1.0	0.3

TABLE NO. A.6-1G.3

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 1G CENTERLINE-CENTER (FLUSH) JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
6 DEGREE APPROACH -- TARGET IAS 72KTS.													
G7	92.4	86.6	5.8	5.9	0.4	93.8	96.6	97.8	5.9	92.6	9.5	10.5	1.2
G8	91.3	83.4	7.8	7.5	0.6	92.9	93.9	95.1	7.4	90.7	11.0	11.5	1.1
G9	89.8	82.4	7.4	7.0	0.5	91.5	93.2	94.6	6.7	90.5	11.5	10.5	1.3
G10	93.4	85.6	7.8	7.2	0.5	94.3	95.7	97.0	6.9	92.6	12.0	11.5	1.3
G11	92.3	84.5	7.8	7.1	0.5	93.3	94.7	96.1	6.8	91.0	12.5	11.5	1.4
Avg.	91.8	84.5	7.3	7.0	0.5	93.2	94.8	96.1	6.8	91.5	11.3	11.1	1.3
Std Dv	1.4	1.7	0.9	0.6	0.1	1.1	1.3	1.3	0.5	1.0	1.2	0.5	0.1
90% CI	1.3	1.6	0.8	0.6	0.1	1.0	1.3	1.3	0.5	1.0	1.1	0.5	0.1
6 DEGREE APPROACH -- TARGET IAS 52KTS.													
H12	93.2	85.0	8.1	7.0	0.4	94.6	94.8	96.4	7.1	91.1	14.5	14.0	1.6
H13	94.5	86.4	8.1	6.8	0.4	95.5	96.7	97.8	6.9	93.1	15.5	13.0	0.9
H14	91.4	83.4	8.0	6.7	0.4	92.5	93.8	94.6	7.0	90.7	15.5	13.5	0.7
H15	92.6	83.2	9.4	7.4	0.5	94.5	93.3	94.5	8.2	89.9	18.5	17.0	1.4
H16	94.3	86.4	7.9	7.3	0.5	95.2	96.4	97.2	7.4	92.3	12.0	12.0	0.8
Avg.	93.2	84.9	8.3	7.1	0.5	94.4	95.0	96.1	7.3	91.4	15.2	13.9	1.1
Std Dv	1.3	1.6	0.6	0.3	0.0	1.2	1.5	1.5	0.5	1.3	2.3	1.9	0.4
90% CI	1.2	1.5	0.6	0.3	0.0	1.1	1.5	1.4	0.5	1.2	2.2	1.8	0.4
9 DEGREE APPROACH -- TARGET IAS 62KTS.													
J23	88.4	80.8	7.6	6.9	0.5	90.7	92.3	94.1	6.4	88.5	12.5	11.0	1.7
J24	89.6	81.2	8.3	7.2	0.5	91.4	92.0	93.0	7.1	88.8	14.5	15.0	1.1
J25	89.0	81.1	7.9	7.0	0.5	90.7	91.7	92.7	7.0	88.9	13.5	14.0	0.9
J26	89.3	81.2	8.1	7.2	0.5	91.4	92.4	93.9	6.7	88.4	13.5	13.0	1.5
Avg.	89.1	81.1	8.0	7.1	0.5	91.0	92.1	93.4	6.8	88.6	13.5	13.2	1.3
Std Dv	0.5	0.2	0.3	0.1	0.0	0.4	0.3	0.7	0.3	0.2	0.8	1.7	0.4
90% CI	0.6	0.2	0.4	0.2	0.0	0.5	0.4	0.8	0.4	0.3	1.0	2.0	0.4
12 DEGREE APPROACH -- TARGET IAS 62KTS.													
L33	88.8	80.9	7.8	7.1	0.5	90.7	91.9	93.0	7.0	89.2	12.5	12.5	1.2
L34	89.5	80.7	8.8	6.1	0.3	91.0	91.4	92.5	6.7	89.5	28.5	18.5	1.1
L35	88.9	80.7	8.2	7.4	0.5	90.4	91.6	92.3	7.4	89.4	12.5	12.5	1.0
L36	93.2	85.4	7.8	7.1	0.5	94.5	95.7	96.5	7.2	91.2	12.5	13.0	0.8
L37	89.3	80.8	8.5	7.1	0.5	91.1	91.5	92.3	7.3	89.1	15.5	16.0	0.8
Avg.	89.9	81.7	8.2	7.0	0.4	91.5	92.4	93.3	7.1	89.7	16.3	14.5	0.9
Std Dv	1.9	2.1	0.4	0.5	0.1	1.7	1.9	1.8	0.3	0.9	6.9	2.7	0.2
90% CI	1.8	2.0	0.4	0.5	0.1	1.6	1.8	1.7	0.3	0.8	6.6	2.5	0.2

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

TABLE NO. A.6-2.1

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 2 SIDELINE - 150 M. SOUTH JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
6 DEGREE APPROACH -- TARGET IAS 62KTS. (ICAO)													
F1	85.6	76.7	8.9	7.2	0.4	87.4	86.8	88.5	7.4	83.7	17.5	16.5	1.7
F2	84.8	75.1	9.6	7.4	0.5	86.6	85.7	87.9	7.1	81.5	19.5	16.5	2.1
F3	84.9	75.8	9.0	7.2	0.4	86.9	86.2	87.4	7.5	84.1	18.0	18.5	1.1
F4	86.1	77.4	8.7	7.3	0.5	88.2	88.0	89.8	7.2	83.6	15.5	14.5	1.8
F5	85.1	77.0	8.1	7.1	0.5	87.0	87.1	88.9	7.2	83.2	14.0	13.5	1.8
F6	84.4	76.8	7.6	6.8	0.4	86.7	87.0	89.1	6.7	83.2	13.0	13.5	2.1
Avg.	85.1	76.5	8.7	7.2	0.5	87.2	86.8	88.6	7.2	83.2	16.2	15.5	1.8
Std Dv	0.6	0.8	0.7	0.2	0.0	0.6	0.8	0.9	0.3	0.9	2.5	2.0	0.4
90% CI	0.5	0.7	0.6	0.2	0.0	0.5	0.6	0.7	0.2	0.8	2.1	1.6	0.3
TAKEOFF -- TARGET IAS 62KTS. (ICAO)													
I17	84.7	74.9	9.9	7.5	0.5	86.9	86.2	87.6	7.1	80.2	21.0	20.0	1.4
I18	84.7	74.8	9.9	7.6	0.5	86.9	86.3	87.5	7.4	80.3	20.0	19.0	1.8
I19	84.8	74.7	10.1	7.6	0.5	86.9	85.8	86.7	7.7	79.9	21.0	20.5	0.9
I20	85.0	74.6	10.3	7.6	0.5	87.3	86.0	87.2	7.5	80.3	23.0	22.5	1.8
I21	84.6	74.3	10.3	7.8	0.5	86.7	85.7	86.8	7.7	80.1	20.5	20.0	1.1
I22	84.3	74.1	10.1	7.6	0.5	86.6	85.5	86.7	7.6	79.8	21.0	20.0	1.1
Avg.	84.7	74.6	10.1	7.6	0.5	86.9	85.9	87.1	7.5	80.1	21.1	20.3	1.3
Std Dv	0.2	0.3	0.2	0.1	0.0	0.3	0.3	0.4	0.2	0.2	1.0	1.2	0.4
90% CI	0.2	0.2	0.2	0.1	0.0	0.2	0.2	0.3	0.2	0.2	0.8	1.0	0.3
TAKEOFF --STANDARD (SEE TEXT)													
K27	83.2	73.7	9.5	7.4	0.5	85.4	84.9	86.2	7.1	80.4	19.5	19.5	1.4
K28	85.0	74.8	10.3	7.7	0.5	87.1	85.9	87.1	7.5	80.2	22.0	21.0	1.3
K30	83.8	73.4	10.4	7.8	0.5	86.1	84.9	86.2	7.4	79.4	22.0	22.5	1.2
K31	84.0	73.7	10.3	7.8	0.5	86.1	85.1	86.2	7.4	79.4	21.0	21.0	1.2
K32	83.7	74.2	9.5	7.4	0.5	86.0	85.3	86.6	7.3	79.1	19.0	19.0	1.3
Avg.	83.9	74.0	10.0	7.6	0.5	86.1	85.2	86.5	7.4	79.7	20.7	20.6	1.3
Std Dv	0.7	0.5	0.5	0.2	0.0	0.6	0.4	0.4	0.2	0.6	1.4	1.4	0.1
90% CI	0.6	0.5	0.4	0.2	0.0	0.6	0.4	0.4	0.1	0.5	1.3	1.3	0.1

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

TABLE NO. A.6-2.2

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 2 SIDELINE - 150 M. SOUTH JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	DASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 125KTS.													
A38	83.0	75.5	7.5	6.9	0.5	85.2	86.7	88.1	6.6	83.6	12.5	12.0	1.3
A39	81.7	73.5	8.2	7.3	0.5	84.0	85.0	86.1	6.9	80.4	13.5	13.5	1.1
A40	81.7	73.9	7.8	7.2	0.5	84.2	85.4	86.7	6.8	81.0	12.5	12.5	1.3
A41	82.1	74.1	7.9	7.2	0.5	84.5	85.5	86.8	7.0	81.0	12.5	12.5	1.3
A42	81.2	73.8	7.4	7.0	0.5	83.6	85.1	86.4	6.8	80.7	11.5	11.5	1.3
A43	81.7	74.3	7.4	6.8	0.4	84.1	85.9	87.3	6.3	81.0	12.5	12.0	1.4
A44	81.3	74.4	6.8	6.6	0.4	83.7	85.9	87.1	6.5	82.5	11.0	10.5	1.2
Avg.	81.8	74.2	7.6	7.0	0.5	84.2	85.7	86.9	6.7	81.5	12.3	12.1	1.3
Std Dv	0.6	0.6	0.4	0.3	0.0	0.5	0.6	0.6	0.2	1.1	0.8	0.9	0.1
90% CI	0.4	0.5	0.3	0.2	0.0	0.4	0.4	0.5	0.2	0.8	0.6	0.7	0.1
500 FT. FLYOVER -- TARGET IAS 111KTS.													
B45	81.3	73.6	7.7	7.2	0.5	84.0	85.0	86.7	6.7	81.1	12.0	12.0	1.6
B46	80.2	72.4	7.8	7.0	0.5	82.7	84.2	85.2	6.9	81.5	13.0	12.5	1.0
B47	81.1	73.5	7.6	6.8	0.4	83.4	85.1	86.5	6.3	80.9	13.0	12.5	1.4
B48	81.1	73.6	7.5	6.8	0.4	83.6	85.3	86.4	6.6	81.5	12.5	12.0	1.1
B49	81.3	73.2	8.1	7.2	0.5	83.9	85.1	86.3	6.6	79.7	13.5	14.0	1.3
Avg.	81.0	73.3	7.8	7.0	0.5	83.5	84.9	86.2	6.6	80.9	12.8	12.6	1.3
Std Dv	0.4	0.5	0.2	0.2	0.0	0.5	0.4	0.6	0.2	0.8	0.6	0.8	0.2
90% CI	0.4	0.5	0.2	0.2	0.0	0.5	0.4	0.6	0.2	0.7	0.5	0.8	0.2
500 FT. FLYOVER -- TARGET IAS 97KTS.													
C50	80.7	72.8	7.9	6.8	0.4	83.4	84.5	85.9	6.4	80.8	14.5	14.5	1.2
C51	81.1	72.7	8.5	7.2	0.5	83.4	84.0	85.4	6.9	79.8	15.0	15.0	1.4
C52	80.5	72.2	8.3	7.3	0.5	83.1	83.8	85.1	7.1	79.8	13.5	13.5	1.5
C53	82.7	74.9	7.8	7.0	0.5	85.0	85.6	86.7	7.4	83.1	13.0	13.0	1.4
Avg.	81.3	73.2	8.1	7.1	0.5	83.7	84.5	85.8	6.9	80.9	14.0	14.0	1.4
Std Dv	1.0	1.2	0.3	0.2	0.0	0.9	0.8	0.7	0.4	1.6	0.9	0.9	0.1
90% CI	1.2	1.4	0.4	0.3	0.0	1.0	0.9	0.9	0.5	1.8	1.1	1.1	0.1
500 FT. FLYOVER -- TARGET IAS 83.5KTS.													
D54	81.2	73.1	8.1	6.6	0.4	83.7	85.1	86.4	6.0	81.0	17.0	17.0	1.3
D55	81.7	73.1	8.6	6.8	0.4	83.9	83.8	85.3	6.8	82.6	18.0	18.0	1.5
D56	81.8	72.6	9.1	7.0	0.4	84.0	84.5	85.9	6.7	80.5	20.0	16.5	1.4
D57	82.3	73.6	8.7	7.2	0.5	84.4	84.3	85.7	7.1	82.9	16.0	16.5	1.4
Avg.	81.7	73.1	8.6	6.9	0.4	84.0	84.4	85.8	6.7	81.7	17.7	17.0	1.4
Std Dv	0.5	0.4	0.4	0.3	0.0	0.3	0.5	0.5	0.5	1.2	1.7	0.7	0.1
90% CI	0.5	0.4	0.5	0.3	0.0	0.3	0.6	0.5	0.6	1.4	2.0	0.8	0.1
1000 FT. FLYOVER -- TARGET IAS 125KTS.													
E58	78.2	68.5	9.7	7.6	0.5	80.4	79.9	81.0	7.1	77.5	18.5	20.5	1.1
E59	77.6	68.3	9.3	7.6	0.5	79.7	79.2	80.2	7.5	79.2	17.0	18.5	1.0
E60	78.4	68.8	9.7	7.4	0.5	80.4	79.9	80.9	7.3	77.0	20.0	19.5	1.0
Avg.	78.1	68.5	9.5	7.5	0.5	80.1	79.6	80.7	7.3	77.9	18.5	19.5	1.1
Std Dv	0.4	0.2	0.2	0.1	0.0	0.4	0.4	0.5	0.2	1.2	1.5	1.0	0.1
90% CI	0.7	0.4	0.4	0.2	0.0	0.7	0.7	0.8	0.3	2.0	2.5	1.7	0.1

TABLE NO. A.6-2.3

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 2 SIDELINE - 150 M. SOUTH JUNE 22,1983

6 DEGREE APPROACH -- TARGET IAS 72KTS.

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
G7	85.3	78.0	7.3	7.0	0.5	87.4	88.5	90.5	6.7	84.5	11.0	10.5	2.1
G8	85.7	77.4	8.3	7.2	0.5	87.7	87.9	90.1	7.1	84.0	14.0	11.5	2.2
G9	86.1	79.1	7.1	6.8	0.5	87.7	89.6	91.5	6.4	84.8	11.0	9.5	1.9
G10	84.2	75.5	8.7	6.7	0.4	86.4	85.9	87.9	6.7	82.7	20.0	19.0	1.9
G11	85.2	76.9	8.2	6.6	0.4	87.2	87.8	89.5	6.4	83.7	17.5	16.0	1.7
Avg.	85.3	77.4	7.9	6.9	0.4	87.3	87.9	89.9	6.7	83.9	14.7	13.3	2.0
Std Dv	0.7	1.3	0.7	0.2	0.1	0.5	1.3	1.3	0.3	0.8	4.0	4.0	0.2
90% CI	0.7	1.3	0.7	0.2	0.1	0.5	1.3	1.3	0.3	0.8	3.8	3.9	0.2

6 DEGREE APPROACH -- TARGET IAS 52KTS.

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
H12	84.0	75.8	8.2	6.3	0.3	86.6	86.5	88.1	6.5	85.2	19.5	20.5	1.6
H13	86.0	76.5	9.5	7.1	0.4	87.8	86.3	87.1	7.9	83.4	22.0	23.0	0.8
H14	86.2	76.1	10.1	7.8	0.5	88.2	86.2	88.5	7.6	82.3	19.5	19.5	2.3
H15	83.9	73.2	10.6	7.2	0.4	86.6	84.1	86.0	7.4	83.7	29.5	27.5	1.9
H16	86.5	77.3	9.1	6.5	0.3	88.1	87.6	90.0	6.5	82.5	25.5	18.0	2.4
Avg.	85.3	75.8	9.5	7.0	0.4	87.5	86.2	87.9	7.2	83.4	23.2	21.7	1.8
Std Dv	1.3	1.5	0.9	0.6	0.1	0.8	1.3	1.5	0.6	1.2	4.3	3.7	0.6
90% CI	1.2	1.5	0.9	0.6	0.1	0.8	1.2	1.4	0.6	1.1	4.1	3.5	0.6

9 DEGREE APPROACH -- TARGET IAS 62KTS.

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
J23	84.5	75.1	9.4	7.7	0.5	86.1	85.2	87.1	7.5	80.9	16.5	16.0	1.9
J24	84.8	75.4	9.5	7.3	0.4	86.7	85.3	86.9	7.4	80.9	20.0	20.5	2.2
J25	84.5	75.5	9.0	7.5	0.5	86.4	85.2	87.3	7.5	81.0	16.0	16.5	2.3
J26	85.3	76.1	9.2	7.3	0.5	86.8	86.3	87.8	7.2	81.1	18.5	18.0	1.6
Avg.	84.8	75.5	9.3	7.4	0.5	86.5	85.5	87.3	7.4	81.0	17.7	17.7	2.0
Std Dv	0.4	0.4	0.2	0.2	0.0	0.3	0.5	0.4	0.1	0.1	1.8	2.0	0.3
90% CI	0.4	0.5	0.2	0.3	0.0	0.4	0.6	0.4	0.2	0.1	2.2	2.4	0.4

12 DEGREE APPROACH -- TARGET IAS 62KTS.

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
L33	83.8	74.1	9.7	7.5	0.5	85.7	84.3	86.2	7.4	80.1	20.0	19.0	1.9
L34	85.1	75.2	9.8	7.3	0.4	86.5	85.3	87.2	6.9	81.4	22.5	21.5	2.3
L35	84.0	75.4	8.6	7.0	0.4	86.0	85.6	87.7	6.9	80.8	17.0	16.0	2.1
L36	86.9	77.9	8.9	7.4	0.5	88.9	88.1	88.9	7.2	84.5	16.0	24.0	0.9
L37	85.5	74.2	11.3	7.5	0.4	87.0	84.4	86.5	7.4	80.3	31.5	26.5	2.1
Avg.	85.0	75.4	9.7	7.3	0.4	86.8	85.5	87.3	7.2	81.4	21.4	21.4	1.9
Std Dv	1.2	1.6	1.1	0.2	0.0	1.2	1.5	1.1	0.2	1.8	6.2	4.1	0.6
90% CI	1.2	1.5	1.0	0.2	0.0	1.2	1.5	1.0	0.2	1.7	5.9	3.9	0.5

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

TABLE NO. A.6-3.1

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 3 SIDELINE - 150 M. NORTH JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
6 DEGREE APPROACH -- TARGET IAS 62KTS. (ICAO)													
F1	83.6	74.8	8.8	6.8	0.4	86.1	85.9	87.7	6.6	83.1	19.5	18.5	1.7
F2	81.5	71.7	9.8	7.3	0.4	84.1	82.8	84.8	7.4	80.9	21.5	18.0	2.0
F3	82.6	73.8	8.8	7.5	0.5	85.4	85.1	86.8	7.4	82.2	15.0	14.5	1.7
F4	81.8	72.4	9.4	7.3	0.5	84.6	83.8	85.9	7.3	81.9	19.0	15.5	2.1
F5	81.0	73.7	7.3	6.2	0.4	83.6	84.8	86.7	6.1	81.4	15.0	13.5	1.9
F6	82.5	74.3	8.2	7.4	0.5	85.3	84.9	86.9	7.5	82.0	13.0	13.0	2.4
Avg.	82.2	73.5	8.7	7.1	0.4	84.8	84.5	86.5	7.0	81.9	17.2	15.5	2.0
Std Dv	0.9	1.2	0.9	0.5	0.1	0.9	1.1	1.0	0.6	0.7	3.3	2.3	0.2
90% CI	0.8	1.0	0.7	0.4	0.1	0.7	0.9	0.8	0.5	0.6	2.7	1.9	0.2
TAKEOFF -- TARGET IAS 62KTS. (ICAO)													
I17	83.1	73.8	9.3	7.1	0.4	85.4	84.1	85.1	7.9	80.3	20.0	20.5	1.0
I18	83.3	73.0	10.3	7.8	0.5	85.4	83.4	84.4	8.0	79.8	21.0	23.5	2.5
I19	83.5	73.4	10.1	7.7	0.5	85.3	83.6	84.7	8.0	80.2	20.5	21.0	1.7
I20	83.9	74.2	9.7	7.2	0.4	86.0	84.9	86.3	7.4	81.6	22.0	20.5	1.4
I21	83.6	74.8	8.8	6.8	0.4	85.5	85.2	86.5	6.9	81.5	20.0	20.5	1.3
I22	83.1	72.7	10.3	7.7	0.5	85.2	83.4	84.6	7.9	79.9	22.0	22.0	1.5
Avg.	83.4	73.7	9.8	7.4	0.5	85.5	84.1	85.3	7.7	80.5	20.9	21.3	1.5
Std Dv	0.3	0.8	0.6	0.4	0.1	0.3	0.8	0.9	0.5	0.8	0.9	1.2	0.5
90% CI	0.3	0.6	0.5	0.3	0.0	0.2	0.6	0.7	0.4	0.6	0.8	1.0	0.4
TAKEOFF -- STANDARD (SEE TEXT)													
K27	83.2	74.4	8.8	7.3	0.5	85.4	85.0	86.6	7.8	82.0	16.0	13.5	2.1
K28	82.9	73.3	9.6	7.5	0.5	84.7	83.7	86.0	7.0	81.1	19.5	17.5	2.2
K30		----------		NO DATA		----------							
K31	83.5	74.0	9.5	7.4	0.5	85.6	84.6	86.7	6.9	82.9	19.0	19.5	2.1
K32	82.6	72.6	10.0	7.7	0.5	84.4	82.8	84.1	7.9	79.1	20.0	20.5	1.3
Avg.	83.0	73.5	9.5	7.5	0.5	85.0	84.0	85.8	7.4	81.3	18.6	17.7	1.9
Std Dv	0.4	0.8	0.5	0.2	0.0	0.6	1.0	1.2	0.5	1.6	1.8	3.1	0.4
90% CI	0.4	0.9	0.6	0.2	0.0	0.7	1.2	1.4	0.6	1.9	2.1	3.6	0.5

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

TABLE NO. A.6-3.2

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 3 SIDELINE - 150 M. NORTH JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 125KTS.													
A38	83.1	75.9	7.2	6.7	0.4	85.0	86.7	87.7	6.7	84.0	12.0	12.5	1.2
A39	81.3	73.5	7.8	6.8	0.4	83.4	84.4	86.0	6.5	81.5	14.0	14.0	1.5
A40	81.7	74.2	7.5	6.8	0.4	83.8	84.8	86.4	6.7	82.1	13.0	12.5	1.6
A41	82.3	75.5	6.8	6.3	0.4	84.4	86.2	87.5	6.3	82.9	12.0	12.0	1.3
A42	81.4	73.2	8.1	6.7	0.4	83.5	83.8	85.3	6.8	81.7	16.5	16.5	1.5
A43	81.3	74.5	6.8	6.4	0.4	83.3	85.0	86.4	6.5	82.0	11.5	11.5	1.4
A44	81.6	74.1	7.5	7.2	0.5	83.7	84.9	86.3	7.3	80.6	11.0	10.5	1.5
Avg.	81.8	74.4	7.4	6.7	0.4	83.9	85.1	86.5	6.7	82.1	12.9	12.8	1.4
Std Dv	0.7	1.0	0.5	0.3	0.0	0.6	1.0	0.8	0.3	1.1	1.9	2.0	0.2
90% CI	0.5	0.7	0.4	0.2	0.0	0.4	0.7	0.6	0.2	0.8	1.4	1.4	0.1
500 FT. FLYOVER -- TARGET IAS 111KTS.													
B45	81.3	74.1	7.2	6.7	0.4	83.6	85.1	86.4	6.6	82.7	12.0	12.0	1.2
B46	79.5	71.2	8.3	7.3	0.5	81.6	82.4	83.4	7.3	79.8	13.5	13.5	1.0
B47	81.2	73.1	8.1	6.9	0.4	83.6	83.9	85.4	7.0	82.4	14.5	14.5	1.6
B48	79.6	71.6	8.0	7.0	0.5	81.8	82.2	83.3	7.5	78.8	13.5	13.5	1.1
B49	80.7	72.8	7.9	6.7	0.4	83.0	83.5	85.0	6.8	79.9	15.0	15.0	1.6
Avg.	80.4	72.6	7.9	6.9	0.5	82.7	83.4	84.7	7.1	80.7	13.7	13.7	1.3
Std Dv	0.9	1.2	0.4	0.2	0.0	0.9	1.2	1.3	0.4	1.7	1.2	1.2	0.3
90% CI	0.8	1.1	0.4	0.2	0.0	0.9	1.1	1.3	0.3	1.6	1.1	1.1	0.3
500 FT. FLYOVER -- TARGET IAS 97KTS.													
C50	80.1	71.2	8.9	7.6	0.5	82.5	82.2	83.5	7.7	80.6	15.0	14.5	1.4
C51	80.9	72.2	8.7	7.2	0.5	83.2	83.3	84.6	7.3	80.9	16.0	15.0	1.6
C52	80.2	71.6	8.6	7.4	0.5	82.3	82.4	83.6	7.5	80.6	14.5	14.5	1.4
C53	81.6	74.6	7.0	6.1	0.4	84.0	85.4	87.2	6.0	81.1	14.0	13.5	1.8
Avg.	80.7	72.4	8.3	7.1	0.5	83.0	83.3	84.7	7.1	80.8	14.9	14.4	1.6
Std Dv	0.7	1.5	0.9	0.7	0.1	0.8	1.5	1.7	0.8	0.2	0.9	0.6	0.2
90% CI	0.8	1.8	1.0	0.8	0.1	0.9	1.7	2.0	0.9	0.3	1.0	0.7	0.2
500 FT. FLYOVER -- TARGET IAS 83.5KTS.													
D54	80.4	72.3	8.1	7.2	0.5	82.7	83.5	85.1	6.8	80.7	13.5	13.5	1.5
D55	81.5	73.3	8.3	7.0	0.4	83.8	83.8	85.7	7.0	80.1	15.5	14.5	1.9
D56	80.5	71.4	9.2	7.0	0.4	82.5	82.4	84.1	6.9	80.2	20.0	16.0	1.7
D57	81.9	74.1	7.8	6.8	0.4	84.0	84.2	86.3	6.8	79.2	14.0	13.5	2.1
Avg.	81.1	72.7	8.3	7.0	0.4	83.3	83.5	85.3	6.9	80.0	15.7	14.4	1.8
Std Dv	0.7	1.2	0.6	0.2	0.0	0.8	0.8	0.9	0.1	0.6	3.0	1.2	0.2
90% CI	0.9	1.4	0.7	0.2	0.0	0.9	0.9	1.1	0.1	0.7	3.5	1.4	0.3
1000 FT. FLYOVER -- TARGET IAS 125KTS.													
E58	77.5	68.8	8.7	7.2	0.5	80.1	80.4	81.7	7.0	79.6	16.0	16.0	1.3
E59	77.0	69.2	7.8	6.6	0.4	79.2	80.1	81.1	6.6	76.9	15.0	17.0	0.9
E60	77.7	69.0	8.7	7.0	0.4	79.9	80.1	81.3	6.9	79.3	17.5	17.0	1.2
Avg.	77.4	69.0	8.4	6.9	0.4	79.7	80.2	81.4	6.8	78.6	16.2	16.7	1.2
Std Dv	0.4	0.2	0.5	0.3	0.0	0.5	0.2	0.3	0.2	1.5	1.3	0.6	0.2
90% CI	0.6	0.3	0.8	0.5	0.0	0.8	0.3	0.5	0.3	2.5	2.1	1.0	0.3

TABLE NO. A.6-3.3

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/16/83

SITE: 3 SIDELINE - 150 M. NORTH JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
6 DEGREE APPROACH -- TARGET IAS 72KTS.													
G7	81.7	72.2	9.5	6.7	0.3	84.0	83.5	85.4	7.2	81.9	27.0	16.0	1.8
G8	81.2	72.6	8.6	7.0	0.4	83.8	83.2	85.2	7.0	81.3	17.0	17.5	2.0
G9	80.5	71.8	8.6	7.3	0.5	83.2	83.2	85.3	6.9	81.4	15.0	14.0	2.1
G10	82.8	74.3	8.5	6.9	0.4	85.2	85.1	86.9	6.8	81.3	17.0	16.5	1.8
G11	82.5	73.6	9.0	7.1	0.4	85.0	84.7	86.6	6.9	82.0	18.0	16.5	1.9
Avg.	81.7	72.9	8.8	7.0	0.4	84.2	83.9	85.8	7.0	81.6	18.8	16.1	1.9
Std Dv	1.0	1.0	0.4	0.3	0.1	0.8	0.9	0.8	0.1	0.3	4.7	1.3	0.1
90% CI	0.9	1.0	0.4	0.2	0.1	0.8	0.8	0.8	0.1	0.3	4.5	1.2	0.1
6 DEGREE APPROACH -- TARGET IAS 52KTS.													
H12	85.1	76.5	8.6	6.2	0.3	86.9	86.1	87.6	6.5	81.1	24.5	28.0	1.4
H13	84.8	73.4	11.5	7.4	0.4	86.6	84.7	86.2	7.0	80.9	35.5	30.0	1.6
H14	82.2	72.6	9.6	7.4	0.5	84.7	82.9	84.8	7.7	80.4	20.0	19.0	2.1
H15	85.5	73.3	12.2	7.4	0.4	87.4	84.4	86.1	7.7	80.7	43.0	30.0	1.7
H16	83.3	73.8	9.5	7.0	0.4	85.7	84.7	86.9	7.0	81.1	23.0	17.5	2.3
Avg.	84.2	73.9	10.3	7.1	0.4	86.3	84.6	86.3	7.2	80.8	29.2	24.9	1.8
Std Dv	1.4	1.5	1.5	0.5	0.1	1.1	1.1	1.0	0.5	0.3	9.7	6.1	0.4
90% CI	1.3	1.4	1.4	0.5	0.1	1.0	1.1	1.0	0.5	0.3	9.2	5.9	0.3
9 DEGREE APPROACH -- TARGET IAS 62KTS.													
J23	81.2	73.1	8.1	6.7	0.4	83.6	83.2	84.6	7.1	82.1	16.0	18.0	1.4
J24	81.2	71.0	10.2	7.6	0.5	83.7	81.8	84.0	7.4	79.2	21.5	20.5	2.1
J25	81.3	73.3	8.1	6.5	0.4	84.0	83.9	86.4	6.4	80.4	17.0	16.0	2.6
J26	81.4	71.7	9.7	7.6	0.5	83.9	82.5	84.7	7.5	79.9	19.0	16.5	2.2
Avg.	81.3	72.3	9.0	7.1	0.4	83.8	82.9	84.9	7.1	80.4	18.4	17.7	2.1
Std Dv	0.1	1.1	1.1	0.6	0.1	0.2	0.9	1.0	0.5	1.2	2.4	2.0	0.5
90% CI	0.1	1.3	1.3	0.7	0.1	0.2	1.1	1.2	0.6	1.5	2.9	2.4	0.6
12 DEGREE APPROACH -- TARGET IAS 62KTS.													
L33	81.4	72.7	8.7	6.7	0.4	83.9	83.4	85.3	6.7	80.2	20.0	19.5	1.8
L34		-----------		NO DATA		-----------							
L35	80.8	72.0	8.8	7.0	0.4	83.7	82.6	85.1	6.9	81.0	18.0	17.5	2.4
L36	82.8	73.8	9.0	6.8	0.4	86.4	85.4	87.7	6.6	82.5	21.0	21.0	2.2
L37	81.8	71.4	10.4	7.0	0.4	84.5	82.3	84.8	6.9	80.8	30.5	25.5	2.6
Avg.	81.7	72.5	9.2	6.9	0.4	84.6	83.4	85.7	6.8	81.1	22.4	20.9	2.2
Std Dv	0.9	1.0	0.8	0.2	0.0	1.2	1.4	1.3	0.2	1.0	5.6	3.4	0.3
90% CI	1.0	1.2	1.0	0.2	0.0	1.4	1.6	1.5	0.2	1.1	6.5	4.0	0.4

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

DOT/TSC
11/15/83

TABLE NO. A.6-4.1

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 4 CENTERLINE - 150 M. WEST JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
6 DEGREE APPROACH -- TARGET IAS 62KTS. (ICAO)													
F1	88.8	80.7	8.0	7.2	0.5	90.0	91.0	91.9	7.3	86.0	13.0	13.0	1.2
F2	86.1	77.8	8.4	7.2	0.5	87.8	88.4	89.4	7.3	83.7	14.5	14.0	1.0
F3	87.9	79.5	8.3	6.9	0.4	89.2	90.2	91.3	6.9	85.9	16.0	14.5	1.0
F4	87.9	81.5	6.4	6.8	0.5	89.3	91.6	92.5	7.2	86.8	9.0	9.0	0.9
F5	85.4	76.8	8.6	7.6	0.5	87.2	87.7	88.7	7.7	83.7	13.5	13.0	1.0
F6	86.8	78.8	8.0	7.1	0.5	88.4	89.4	90.4	7.1	84.8	13.5	13.0	1.0
Avg.	87.1	79.2	8.0	7.1	0.5	88.7	89.7	90.7	7.2	85.1	13.2	12.7	1.0
Std Dv	1.3	1.8	0.8	0.3	0.0	1.0	1.5	1.5	0.3	1.3	2.3	1.9	0.1
90% CI	1.0	1.4	0.6	0.2	0.0	0.9	1.2	1.2	0.2	1.0	1.9	1.6	0.1
TAKEOFF -- TARGET IAS 62KTS. (ICAO)													
I17	82.0	73.4	8.6	7.2	0.5	83.8	84.1	85.1	7.1	79.4	15.5	16.5	1.1
I18	82.4	73.9	8.5	7.4	0.5	84.1	84.3	85.6	7.4	79.3	14.5	14.0	1.3
I19	82.1	73.6	8.5	7.3	0.5	83.7	83.6	84.6	7.6	79.0	15.0	16.0	1.1
I20	82.7	73.0	9.6	6.9	0.4	84.4	83.0	84.2	7.1	78.8	25.0	28.0	1.2
I21	82.9	72.4	10.5	7.8	0.5	84.5	82.4	83.6	8.0	77.9	22.0	23.0	1.2
I22	82.7	73.7	9.0	7.3	0.5	84.2	83.9	84.9	7.3	78.9	17.0	19.5	1.0
Avg.	82.5	73.3	9.1	7.3	0.5	84.1	83.6	84.7	7.4	78.9	18.2	19.5	1.1
Std Dv	0.4	0.5	0.8	0.3	0.0	0.3	0.7	0.7	0.3	0.5	4.3	5.2	0.1
90% CI	0.3	0.4	0.6	0.2	0.0	0.3	0.6	0.6	0.3	0.4	3.6	4.3	0.1
TAKEOFF -- STANDARD (SEE TEXT)													
K27	82.3	74.8	7.5	6.7	0.4	84.2	85.5	86.7	6.8	80.7	13.0	13.0	1.1
K28	82.4	75.0	7.5	6.6	0.4	84.3	85.1	86.0	7.2	80.3	13.5	14.0	1.0
K30	82.5	73.9	8.6	7.2	0.5	84.2	84.4	86.0	7.1	79.8	15.5	14.5	1.5
K31	82.6	73.5	9.1	7.5	0.5	-	83.5	84.8	-	79.5	16.5	-	1.4
K32	82.1	74.0	8.1	6.9	0.4	83.6	84.3	85.4	7.0	80.0	14.5	15.0	1.2
Avg.	82.4	74.2	8.1	7.0	0.4	84.1	84.5	85.8	7.0	80.1	14.6	14.1	1.2
Std Dv	0.2	0.6	0.7	0.3	0.0	0.3	0.8	0.7	0.2	0.5	1.4	0.9	0.2
90% CI	0.2	0.6	0.7	0.3	0.0	0.4	0.8	0.7	0.2	0.4	1.4	1.0	0.2

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

TABLE NO. A.6-4.2

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 4 CENTERLINE - 150 M. WEST JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 125KTS.													
A38	82.5	76.2	6.3	7.0	0.5	85.0	87.6	88.8	6.6	83.7	8.0	8.5	1.2
A39	80.7	73.2	7.5	7.1	0.5	83.2	84.7	85.6	7.0	83.8	11.5	12.0	0.9
A40	81.4	73.9	7.6	6.9	0.5	84.3	85.6	86.6	6.9	83.5	12.5	13.0	1.0
A41	81.2	74.5	6.8	6.8	0.5	84.0	86.4	87.4	6.6	84.1	10.0	10.0	1.0
A42	80.5	73.1	7.4	7.0	0.5	83.2	84.9	85.9	6.7	83.4	11.5	12.5	1.0
A43	80.9	74.1	6.8	7.0	0.5	83.8	85.7	86.9	6.9	84.0	9.5	10.0	1.1
A44	80.3	74.6	5.8	6.4	0.5	82.9	86.1	86.8	6.6	83.3	8.0	8.5	0.7
Avg.	81.1	74.2	6.9	6.9	0.5	83.8	85.9	86.9	6.7	83.7	10.1	10.6	1.0
Std Dv	0.7	1.0	0.7	0.2	0.0	0.7	1.0	1.0	0.2	0.3	1.8	1.9	0.2
90% CI	0.5	0.8	0.5	0.2	0.0	0.5	0.7	0.8	0.1	0.2	1.3	1.4	0.1
500 FT. FLYOVER -- TARGET IAS 111KTS.													
B45	80.3	73.6	6.7	6.7	0.5	83.1	85.5	86.5	6.7	82.7	10.0	10.0	1.1
B46	80.0	73.1	6.8	6.5	0.4	82.6	84.7	85.7	6.5	82.8	11.0	11.5	1.0
B47	80.7	74.1	6.6	6.8	0.5	83.6	86.4	87.6	6.3	83.8	9.5	9.0	1.2
B48	79.7	72.9	6.8	6.9	0.5	82.3	84.4	85.5	6.9	82.8	9.5	9.5	1.1
B49	80.6	73.4	7.3	7.0	0.5	83.4	85.0	86.1	6.8	83.3	11.0	11.5	1.2
Avg.	80.3	73.4	6.8	6.8	0.5	83.0	85.2	86.3	6.7	83.1	10.2	10.3	1.1
Std Dv	0.4	0.4	0.2	0.2	0.0	0.5	0.8	0.8	0.3	0.5	0.8	1.2	0.1
90% CI	0.4	0.4	0.2	0.2	0.0	0.5	0.7	0.8	0.2	0.4	0.7	1.1	0.1
500 FT. FLYOVER -- TARGET IAS 97KTS.													
C50	79.8	72.5	7.3	6.9	0.5	82.6	84.2	85.3	6.9	82.6	11.5	11.5	1.1
C51	79.4	72.7	6.7	7.4	0.6	-	84.3	85.4	-	82.9	8.0	-	1.1
C52	80.0	73.6	6.4	6.5	0.5	82.7	85.2	86.2	6.4	83.0	9.5	10.0	1.0
C53	83.3	78.1	5.2	6.2	0.5	86.7	90.7	91.7	6.1	86.5	7.0	6.5	1.2
Avg.	80.6	74.2	6.4	6.7	0.5	84.0	86.1	87.2	6.5	83.8	9.0	9.3	1.1
Std Dv	1.8	2.6	0.9	0.5	0.1	2.3	3.1	3.1	0.4	1.8	2.0	2.6	0.1
90% CI	2.1	3.1	1.0	0.6	0.1	3.9	3.7	3.6	0.7	2.2	2.3	4.3	0.1
500 FT. FLYOVER -- TARGET IAS 83.5KTS.													
D54	81.4	74.5	6.9	7.1	0.5	84.4	86.7	87.8	6.8	82.9	9.5	9.5	1.1
D55	82.6	74.8	7.8	7.6	0.6	85.6	87.3	88.3	7.3	84.1	10.5	10.0	1.0
D56	81.5	74.7	6.8	6.7	0.5	84.1	86.3	87.1	6.9	83.3	10.5	10.0	0.8
D57	83.4	77.1	6.3	6.6	0.5	86.2	89.1	90.2	6.4	84.3	9.0	8.5	1.1
Avg.	82.2	75.3	7.0	7.0	0.5	85.1	87.3	88.4	6.9	83.6	9.9	9.5	1.0
Std Dv	1.0	1.2	0.6	0.5	0.1	1.0	1.2	1.3	0.4	0.6	0.7	0.7	0.1
90% CI	1.1	1.4	0.7	0.5	0.1	1.2	1.5	1.6	0.4	0.7	0.9	0.8	0.2
1000 FT. FLYOVER -- TARGET IAS 125KTS.													
E58	76.9	67.1	9.7	7.5	0.5	79.4	78.3	79.5	7.4	78.0	19.5	22.0	1.2
E59	76.0	67.0	9.0	7.7	0.5	78.0	77.7	78.8	7.8	77.3	15.0	15.5	1.0
E60	76.4	67.2	9.2	7.2	0.4	78.7	77.9	79.3	7.3	77.1	18.5	20.0	1.4
Avg.	76.4	67.1	9.3	7.5	0.5	78.7	78.0	79.2	7.5	77.5	17.7	19.2	1.2
Std Dv	0.4	0.1	0.4	0.2	0.0	0.7	0.3	0.4	0.3	0.5	2.4	3.3	0.2
90% CI	0.7	0.2	0.6	0.4	0.1	1.1	0.5	0.6	0.5	0.8	4.0	5.6	0.3

TABLE NO. A.6-4.3

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 4 CENTERLINE - 150 M. WEST JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
6 DEGREE APPROACH -- TARGET IAS 72KTS.													
G7	85.8	78.3	7.5	7.0	0.5	87.7	89.8	90.6	6.7	85.2	11.5	11.5	0.8
G8	84.5	76.9	7.7	7.0	0.5	86.2	87.6	88.7	7.0	83.8	12.5	12.0	1.1
G9	84.8	77.3	7.6	7.3	0.5	86.7	88.2	89.4	7.1	84.1	11.0	10.5	1.2
G10	87.6	80.2	7.3	6.1	0.3	89.2	90.9	91.9	6.4	86.7	16.0	13.5	1.0
G11	87.4	79.2	8.2	6.8	0.4	88.7	89.7	91.1	6.8	85.3	16.0	13.5	1.4
Avg.	86.0	78.4	7.6	6.8	0.4	87.7	89.2	90.3	6.8	85.0	13.4	12.2	1.1
Std Dv	1.4	1.4	0.3	0.5	0.1	1.3	1.3	1.3	0.3	1.1	2.4	1.3	0.2
90% CI	1.3	1.3	0.3	0.4	0.1	1.2	1.3	1.2	0.3	1.1	2.3	1.2	0.2
6 DEGREE APPROACH -- TARGET IAS 52KTS.													
H12	87.7	78.9	8.8	6.6	0.4	90.0	89.9	91.2	6.6	84.8	21.5	21.5	1.3
H13	90.9	82.4	8.4	6.5	0.4	91.7	92.5	93.9	6.3	85.8	19.5	17.5	1.3
H14	88.3	79.9	8.4	7.1	0.5	89.7	90.7	91.6	7.0	84.9	15.0	14.5	0.8
H15	87.1	77.4	9.7	7.1	0.4	89.4	88.6	89.4	7.3	83.8	23.0	23.0	0.8
H16	90.5	80.4	10.2	7.8	0.5	91.4	90.4	91.5	7.8	85.4	20.0	19.0	1.1
Avg.	88.9	79.8	9.1	7.0	0.4	90.4	90.4	91.5	7.0	85.0	19.8	19.1	1.1
Std Dv	1.7	1.9	0.8	0.5	0.1	1.1	1.4	1.6	0.6	0.7	3.0	3.3	0.3
90% CI	1.6	1.8	0.8	0.5	0.1	1.0	1.4	1.5	0.6	0.7	2.9	3.2	0.2
9 DEGREE APPROACH -- TARGET IAS 62KTS.													
J23	84.3	75.7	8.5	6.7	0.4	85.7	86.5	87.5	7.1	81.8	18.5	14.5	1.0
J24	84.6	75.8	8.8	7.6	0.5	86.4	86.5	87.4	7.6	82.6	14.5	15.0	1.0
J25	84.0	76.0	8.0	7.3	0.5	85.4	86.4	87.2	7.3	83.4	12.5	13.0	0.8
J26	85.8	77.5	8.3	6.8	0.4	87.2	88.0	88.7	7.1	81.9	16.5	16.0	0.7
Avg.	84.7	76.3	8.4	7.1	0.5	86.2	86.9	87.7	7.3	82.4	15.5	14.6	0.9
Std Dv	0.8	0.8	0.3	0.4	0.1	0.8	0.8	0.7	0.2	0.8	2.6	1.2	0.1
90% CI	0.9	1.0	0.4	0.5	0.1	1.0	0.9	0.8	0.3	0.9	3.0	1.5	0.2
12 DEGREE APPROACH -- TARGET IAS 62KTS.													
L33	83.8	74.9	8.9	7.6	0.5	85.4	85.3	86.1	7.7	81.8	15.0	16.0	0.8
L34	85.3	75.9	9.4	7.4	0.5	86.8	86.4	87.5	7.4	83.2	18.5	18.5	1.1
L35	83.9	75.0	8.9	7.2	0.4	85.4	85.5	86.3	7.1	82.0	17.5	19.0	1.0
L36	88.9	81.8	7.1	6.8	0.5	89.5	91.4	92.1	6.8	86.5	11.0	12.5	0.7
L37	84.8	75.0	9.7	7.6	0.5	86.0	85.4	86.1	7.6	82.6	19.0	20.0	0.8
Avg.	85.3	76.5	8.8	7.3	0.5	86.6	86.8	87.6	7.3	83.2	16.2	17.2	0.9
Std Dv	2.1	3.0	1.0	0.3	0.0	1.7	2.6	2.6	0.4	1.9	3.3	3.0	0.2
90% CI	2.0	2.8	1.0	0.3	0.0	1.6	2.5	2.4	0.4	1.8	3.1	2.9	0.2

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

TABLE NO. A.6-5.1

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 5 CENTERLINE - 188 M. EAST JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
6 DEGREE APPROACH -- TARGET IAS 62KTS. (ICAO)													
F1	90.5	82.9	7.6	7.0	0.5	92.2	94.5	95.5	6.5	89.5	12.0	11.0	1.0
F2	90.3	82.9	7.3	7.0	0.5	92.0	93.9	94.9	6.8	89.1	11.0	11.0	1.1
F3	91.6	83.9	7.7	7.1	0.5	93.2	95.0	96.0	6.9	90.2	12.0	11.0	0.9
F4	89.8	82.7	7.1	7.2	0.5	91.4	93.7	94.6	7.0	88.7	9.5	9.5	0.9
F5	89.0	82.4	6.6	6.6	0.5	90.9	93.1	94.1	6.8	88.8	10.0	10.0	1.0
F6	88.7	81.0	7.7	7.7	0.6	90.9	92.5	93.7	7.3	88.2	10.0	9.5	1.4
Avg.	90.0	82.6	7.3	7.1	0.5	91.8	93.8	94.8	6.9	89.1	10.7	10.3	1.1
Std Dv	1.1	1.0	0.4	0.3	0.0	0.9	0.9	0.8	0.3	0.7	1.1	0.8	0.2
90% CI	0.9	0.8	0.3	0.3	0.0	0.7	0.8	0.7	0.2	0.6	0.9	0.6	0.2
TAKEOFF -- TARGET IAS 62KTS. (ICAO)													
I17	86.7	79.8	6.9	6.9	0.5	89.3	91.3	92.4	6.8	85.6	10.0	10.5	1.1
I18	86.7	79.0	7.7	7.4	0.5	89.1	90.5	91.6	7.2	85.5	11.0	11.0	1.2
I19	86.4	78.6	7.8	7.2	0.5	88.7	89.8	91.0	6.9	84.7	12.0	13.0	1.2
I20	86.0	78.6	7.3	7.0	0.5	88.6	90.0	91.1	7.1	85.1	11.0	11.5	1.1
I21	86.0	78.9	7.1	7.2	0.5	88.6	90.3	91.6	6.8	85.1	9.5	11.0	1.3
I22	85.8	78.5	7.3	7.3	0.5	88.4	90.2	91.3	6.9	85.1	10.0	10.5	1.2
Avg.	86.2	78.9	7.3	7.2	0.5	88.8	90.3	91.5	6.9	85.2	10.6	11.2	1.2
Std Dv	0.4	0.5	0.4	0.2	0.0	0.4	0.5	0.5	0.2	0.3	0.9	0.9	0.1
90% CI	0.3	0.4	0.3	0.2	0.0	0.3	0.4	0.4	0.1	0.3	0.8	0.8	0.1
TAKEOFF -- STANDARD (SEE TEXT)													
K27	85.7	79.4	6.4	7.0	0.5	88.4	91.0	92.2	6.7	85.7	8.0	8.5	1.2
K28	86.5	80.2	6.4	6.8	0.5	89.1	91.6	92.8	6.8	87.1	8.5	8.5	1.1
K30	86.0	79.0	7.0	7.0	0.5	88.3	90.3	91.4	6.9	85.5	10.0	10.0	1.1
K31	86.9	81.1	5.8	6.8	0.5	89.4	92.6	93.9	6.6	87.7	7.0	7.0	1.3
K32	86.4	80.1	6.4	6.5	0.5	88.8	91.5	92.8	6.3	86.8	9.5	9.0	1.2
Avg.	86.3	79.9	6.4	6.8	0.5	88.8	91.4	92.6	6.7	86.6	8.6	8.6	1.2
Std Dv	0.5	0.8	0.4	0.2	0.0	0.5	0.8	0.9	0.2	1.0	1.2	1.1	0.1
90% CI	0.4	0.8	0.4	0.2	0.0	0.4	0.8	0.9	0.2	0.9	1.1	1.0	0.1

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

TABLE NO. A.6-5.2

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 5 CENTERLINE - 188 M. EAST JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 125KTS.													
A38	82.3	76.1	6.2	6.7	0.5	85.1	87.9	89.0	6.4	84.9	8.5	9.0	1.1
A39	81.7	74.8	6.9	6.9	0.5	84.5	86.5	87.6	6.9	84.5	10.0	10.0	1.1
A40	81.2	74.0	7.2	7.1	0.5	84.1	86.3	87.2	6.7	84.2	10.5	10.5	1.0
A41	81.0	74.0	7.0	6.9	0.5	84.0	86.2	87.3	6.6	84.0	10.5	10.5	1.2
A42	80.7	74.0	6.7	7.0	0.5	83.6	85.9	87.1	6.8	84.2	9.0	9.0	1.2
A43	80.9	74.2	6.6	6.6	0.5	83.8	86.2	87.3	6.5	84.3	10.0	10.0	1.1
A44	81.0	74.9	6.1	6.4	0.5	84.1	87.0	88.2	6.3	84.5	9.0	8.5	1.1
Avg.	81.3	74.6	6.7	6.8	0.5	84.2	86.6	87.7	6.6	84.4	9.6	9.6	1.1
Std Dv	0.6	0.8	0.4	0.2	0.0	0.5	0.7	0.7	0.2	0.3	0.8	0.8	0.1
90% CI	0.4	0.6	0.3	0.2	0.0	0.4	0.5	0.5	0.1	0.2	0.6	0.6	0.0
500 FT. FLYOVER -- TARGET IAS 111KTS.													
B45	81.8	75.4	6.4	6.9	0.5	85.0	87.6	88.7	6.5	84.8	8.5	9.0	1.1
B46	80.2	73.1	7.0	7.2	0.5	83.1	85.4	86.7	6.8	83.5	9.5	9.0	1.2
B47	80.9	73.9	7.0	7.0	0.5	83.8	85.9	86.9	6.9	84.1	10.0	10.0	1.0
B48	80.7	73.6	7.1	6.7	0.4	83.6	85.8	87.0	6.5	83.9	11.5	10.5	1.2
B49	80.8	73.0	7.8	7.3	0.5	83.7	84.9	86.0	7.1	83.4	11.5	12.0	1.1
Avg.	80.9	73.8	7.1	7.0	0.5	83.8	85.9	87.0	6.8	83.9	10.2	10.1	1.1
Std Dv	0.6	1.0	0.5	0.3	0.0	0.7	1.0	1.0	0.3	0.6	1.3	1.2	0.1
90% CI	0.6	0.9	0.5	0.2	0.0	0.6	1.0	1.0	0.3	0.5	1.2	1.2	0.1
500 FT. FLYOVER -- TARGET IAS 97KTS.													
C50	80.6	73.0	7.6	7.1	0.5	83.6	85.3	86.6	7.0	83.7	11.5	10.0	1.3
C51	80.9	73.1	7.8	7.2	0.5	83.7	84.8	85.8	7.4	83.4	12.0	11.5	0.9
C52	81.2	74.1	7.1	7.1	0.5	84.6	87.2	88.4	6.4	84.0	10.0	9.5	1.1
C53	83.3	76.7	6.6	6.5	0.4	86.6	89.1	90.3	6.4	86.3	10.5	9.5	1.2
Avg.	81.5	74.2	7.3	7.0	0.5	84.6	86.6	87.8	6.8	84.4	11.0	10.1	1.1
Std Dv	1.2	1.7	0.5	0.3	0.0	1.4	1.9	2.0	0.5	1.3	0.9	0.9	0.2
90% CI	1.4	2.0	0.6	0.4	0.0	1.6	2.3	2.3	0.6	1.6	1.1	1.1	0.2
500 FT. FLYOVER -- TARGET IAS 83.5KTS.													
D54	81.6	74.1	7.5	6.8	0.4	84.5	86.5	87.4	6.5	83.9	12.5	12.5	0.9
D55	82.7	75.4	7.3	6.6	0.4	85.8	87.7	88.8	6.7	84.8	12.5	11.5	1.1
D56	81.4	74.0	7.4	6.7	0.4	83.9	86.2	87.4	6.7	83.8	13.0	9.5	1.2
D57	83.8	76.1	7.7	7.1	0.5	87.0	88.4	89.5	7.1	85.0	12.5	11.5	1.1
Avg.	82.4	74.9	7.5	6.8	0.4	85.3	87.2	88.3	6.7	84.4	12.6	11.2	1.1
Std Dv	1.1	1.0	0.2	0.2	0.0	1.4	1.0	1.0	0.3	0.6	0.2	1.3	0.1
90% CI	1.3	1.2	0.2	0.2	0.0	1.6	1.2	1.2	0.3	0.7	0.3	1.5	0.1
1000 FT. FLYOVER -- TARGET IAS 125KTS.													
E58		----------		NO DATA		----------							
E59	76.2	66.6	9.6	7.8	0.5	78.6	78.2	79.4	7.6	77.8	17.0	16.5	1.1
E60	77.2	67.6	9.6	7.7	0.5	79.6	78.9	80.2	7.5	78.0	18.0	18.0	1.3
Avg.	76.7	67.1	9.6	7.7	0.5	79.1	78.6	79.8	7.5	77.9	17.5	17.2	1.2
Std Dv	0.7	0.7	0.0	0.1	0.0	0.7	0.5	0.6	0.1	0.2	0.7	1.1	0.1
90% CI	3.2	3.1	0.1	0.4	0.1	3.2	2.1	2.7	0.3	0.8	3.2	4.7	0.5

TABLE NO. A.6-5.3

HUGHES 500D HELICOPTER

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
11/15/83

SITE: 5 CENTERLINE - 188 M. EAST JUNE 22,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
6 DEGREE APPROACH -- TARGET IAS 72KTS.													
G7	89.9	83.6	6.3	6.6	0.5	92.2	95.1	96.5	6.2	90.3	9.0	8.5	1.4
G8	90.8	84.8	6.1	6.7	0.5	92.7	95.9	96.7	6.7	91.1	8.0	8.0	0.7
G9	87.2	81.4	5.8	6.3	0.4	89.7	93.3	94.4	6.1	88.5	8.5	7.5	1.0
G10	89.4	81.4	7.9	7.3	0.5	91.4	93.3	94.3	6.7	87.4	12.0	11.5	1.0
G11	88.6	82.3	6.3	6.6	0.5	90.6	93.6	94.6	6.3	88.6	9.0	9.0	1.0
Avg.	89.2	82.7	6.5	6.7	0.5	91.3	94.3	95.3	6.4	89.2	9.3	8.9	1.0
Std Dv	1.4	1.5	0.8	0.4	0.0	1.2	1.2	1.2	0.3	1.5	1.6	1.6	0.2
90% CI	1.3	1.4	0.8	0.4	0.0	1.1	1.1	1.1	0.2	1.4	1.5	1.5	0.2
6 DEGREE APPROACH -- TARGET IAS 52KTS.													
H12	90.9	82.1	8.8	7.6	0.5	92.3	93.0	94.0	7.3	88.8	14.5	14.0	1.0
H13	92.8	85.4	7.4	6.8	0.5	94.1	96.3	97.2	6.5	90.4	12.0	11.5	1.0
H14	90.0	83.9	6.1	6.4	0.5	92.3	95.0	96.0	6.5	89.2	9.0	9.5	1.0
H15	91.5	83.4	8.1	7.0	0.5	93.1	93.4	94.4	7.4	88.0	14.0	15.0	1.0
H16	92.8	86.7	6.0	6.5	0.5	94.1	97.1	98.0	6.5	91.3	8.5	8.5	0.9
Avg.	91.6	84.3	7.3	6.9	0.5	93.2	94.9	95.9	6.8	89.5	11.6	11.7	1.0
Std Dv	1.2	1.8	1.2	0.5	0.0	0.9	1.8	1.8	0.5	1.3	2.8	2.8	0.1
90% CI	1.1	1.7	1.1	0.4	0.0	0.9	1.7	1.7	0.4	1.2	2.6	2.7	0.1
9 DEGREE APPROACH -- TARGET IAS 62KTS.													
J23	86.8	80.4	6.3	6.6	0.5	88.5	91.3	92.2	6.6	86.3	9.0	9.0	0.9
J24	91.8	85.8	6.0	6.6	0.5	93.3	96.4	97.5	6.4	90.8	8.0	8.0	1.1
J25	89.4	82.3	7.0	6.9	0.5	91.2	93.3	94.1	7.1	89.1	10.5	10.0	0.8
J26	87.2	80.8	6.4	6.3	0.4	89.3	92.1	92.9	6.3	87.1	10.5	10.0	0.7
Avg.	88.8	82.3	6.4	6.6	0.5	90.6	93.3	94.2	6.6	88.3	9.5	9.2	0.9
Std Dv	2.3	2.4	0.4	0.2	0.0	2.2	2.3	2.4	0.3	2.0	1.2	1.0	0.1
90% CI	2.7	2.9	0.5	0.3	0.0	2.5	2.7	2.8	0.4	2.4	1.4	1.1	0.2
12 DEGREE APPROACH -- TARGET IAS 62KTS.													
L33	87.4	80.8	6.6	6.6	0.5	90.1	92.5	93.6	6.6	88.2	10.0	10.0	1.1
L34	87.7	81.3	6.4	6.7	0.5	89.5	92.3	93.3	6.5	87.4	9.0	9.0	1.0
L35	87.3	80.6	6.7	6.7	0.5	89.7	91.9	92.9	6.8	87.4	10.0	10.0	1.0
L36	91.6	85.5	6.1	6.1	0.4	93.7	96.5	97.2	6.5	91.0	10.0	10.0	0.7
L37	90.3	84.2	6.0	6.3	0.4	92.0	95.1	96.0	6.3	89.4	9.0	9.0	0.9
Avg.	88.9	82.5	6.3	6.5	0.5	91.0	93.7	94.6	6.5	88.7	9.6	9.6	0.9
Std Dv	2.0	2.2	0.3	0.3	0.0	1.8	2.0	1.9	0.2	1.5	0.5	0.5	0.1
90% CI	1.9	2.1	0.3	0.2	0.0	1.7	1.9	1.8	0.2	1.5	0.5	0.5	0.1

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

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 9.4.

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 hiistory "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: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER (0.9*VH)/TARGET IAS=125 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
A38	82.1	75.5	9	6.9	.5
A39	81.2	74.3	10	6.9	.5
A40	80.9	73.7	10	7.2	.5
A41	80.7	73.9	10	6.8	.5
A42	80.4	73.6	10	6.8	.5
A43	80.6	74	10	6.6	.5
A44	80.6	74.5	9	6.4	.5
AVERAGE	80.90	74.20	9.70	6.80	.5
N	7	7	7	7	7
STD.DEV.	0.58	0.65	0.49	.25	.03
90% C.I.	0.42	0.48	0.36	.19	.02

TABLE B.1.2

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER (0.9*VH)/TARGET IAS=125 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
A38	81.8	74.7	10	7.1	.5
A39	80.8	73.2	11	7.3	.5
A40	80.8	73.3	10	7.5	.6
A41	81.2	74.1	8.5	7.6	.6
A42	80.1	72.9	10	7.2	.5
A43	80.5	73.1	11	7.1	.5
A44	80.4	73.9	9	6.8	.5
AVERAGE	80.80	73.60	9.90	7.20	.5
N	7	7	7	7	7
STD.DEV.	0.56	0.65	0.93	.27	.04
90% C.I.	0.41	0.48	0.68	.2	.03

TABLE B.1.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER (0.9*VH)/TARGET IAS=125 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
A38	82.9	75.9	10	7	.5
A39	81.2	73.4	12	7.2	.5
A40	81.6	73.9	12	7.1	.5
A41	81.6	74.7	10	6.9	.5
A42	80.6	73.2	11	7.1	.5
A43	81.2	73.8	10	7.4	.6
A44	80.7	75.2	9	5.8	.4
AVERAGE	81.40	74.30	10.60	6.90	.5
N	7	7	7	7	7
STD.DEV.	0.77	1.00	1.13	.54	.05
90% C.I.	0.56	0.73	0.83	.4	.04

TABLE B.2.1

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER (0.8*VH)/TARGET IAS=111 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
B45	81.5	75	9	6.8	.5
B46	79.6	72.7	10	6.9	.5
B47	80.4	73.5	10	6.9	.5
B48	80.1	73.1	12	6.5	.4
B49	80.3	72.6	12	7.1	.5
AVERAGE	80.40	73.40	10.60	6.80	.5
N	5	5	5	5	5
STD.DEV.	0.70	0.97	1.54	.23	.03
90% C.I.	0.67	0.93	1.28	.22	.03

TABLE B.2.2

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER (0.8*VH)/TARGET IAS=111 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
B45	80.5	73.6	10	6.9	.5
B46	79.1	71.8	11	7	.5
B47	80.4	72.7	11	7.4	.5
B48	79.3	71.9	10	7.4	.5
B49	80.4	72.4	13	7.2	.5
AVERAGE	79.90	72.50	11.00	7.20	.5
N	5	5	5	5	5
STD.DEV.	0.68	0.73	1.22	.22	.03
90% C.I.	0.65	0.69	1.17	.21	.03

TABLE B.2.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER (0.8*VH)/TARGET IAS=111 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
B45	80.6	73	11	7.3	.5
B46	79.9	72.7	11	6.9	.5
B47	80.9	73.7	10	7.2	.5
B48	79.8	72.5	10	7.3	.5
B49	80.9	73.1	11	7.5	.6
AVERAGE	80.40	73.00	10.60	7.20	.5
N	5	5	5	5	5
STD.DEV.	0.54	0.46	0.55	.21	.03
90% C.I.	0.51	0.44	0.52	.2	.03

TABLE B.3.1

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER (0.7*VH)/TARGET IAS=97 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
C50	80.2	72.7	11	7.2	.5
C51	80.5	72.9	12	7	.5
C52	80.8	73.5	10	7.3	.5
C53	83	76.3	11	6.4	.4
AVERAGE	81.10	73.90	11.00	7.00	.5
N	4	4	4	4	4
STD.DEV.	1.27	1.67	0.82	.39	.05
90% C.I.	1.50	1.96	0.96	.46	.06

TABLE B.3.2

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER (0.7*VH)/TARGET IAS=97 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
C50	80.2	72.7	10	7.5	.6
C51	80.3	72.1	12	7.6	.6
C52	79.4	71.8	12	7	.5
C53	83.8	77.3	9	6.8	.5
AVERAGE	80.90	73.50	10.80	7.20	.5
N	4	4	4	4	4
STD.DEV.	1.96	2.58	1.50	.37	.04
90% C.I.	2.30	3.03	1.77	.44	.05

TABLE B.3.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER (0.7*VH)/TARGET IAS=97 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
C50	79.9	72.2	11	7.4	.5
C51	80.9	73.1	11	7.5	.6
C52	80.1	73.2	10	6.9	.5
C53	83.7	77.7	8	6.6	.5
AVERAGE	81.20	74.10	10.00	7.10	.5
N	4	4	4	4	4
STD.DEV.	1.75	2.47	1.41	.4	.03
90% C.I.	2.06	2.91	1.66	.47	.03

TABLE B.4.1

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER (0.6*VH)/TARGET IAS=83.5 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
D54	81.2	73.6	12	7	.5
D55	82.4	74.9	12.5	6.8	.4
D56	80.8	73.6	10	7.2	.5
D57	83.5	75.9	12.5	6.9	.5
AVERAGE	82.00	74.50	11.80	7.00	.5
N	4	4	4	4	4
STD.DEV.	1.22	1.12	1.19	.16	.03
90% C.I.	1.44	1.31	1.40	.18	.04

TABLE B.4.2

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER (0.6*VH)/TARGET IAS=83.5 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
D54	81.4	74.4	10	7	.5
D55	82.6	75.7	9	7.2	.5
D56	81.1	73.1	11.5	7.5	.5
D57	84.2	76.3	10	7.9	.6
AVERAGE	82.30	74.90	10.10	7.40	.6
N	4	4	4	4	4
STD.DEV.	1.41	1.42	1.03	.39	.05
90% C.I.	1.66	1.68	1.21	.46	.06

TABLE B.4.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER (0.6*VH)/TARGET IAS=83.5 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
D54	0	0	10	0	.1
D55	82.6	75	10	7.6	.6
D56	81.5	74	11	7.2	.5
D57	83.7	76.4	10	7.3	.5
AVERAGE	62.00	56.40	10.30	5.50	.4
N	4	4	4	4	4
STD.DEV.	41.31	37.58	0.50	3.69	.22
90% C.I.	48.61	44.22	0.59	4.34	.26

TABLE B.5.1

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 1000 FT.FLYOVER (0.9*VH)/TARGET IAS=125 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
E58	76.7	68.3	17	6.8	.4
E59	75	66.5	16	7.1	.4
E60	76.8	67.6	18	7.3	.5
AVERAGE	76.20	67.50	17.00	7.10	.4
N	3	3	3	3	3
STD.DEV.	1.01	0.91	1.00	.25	.03
90% C.I.	1.71	1.53	1.69	.42	.05

TABLE B.5.2

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 1000 FT.FLYOVER (0.9*VH)/TARGET IAS=125 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
E58	75.8	66.6	20	7.1	.4
E59	75.9	67.5	15	7.1	.5
E60	76.4	66.9	18.5	7.5	.5
AVERAGE	76.00	67.00	17.80	7.20	.5
N	3	3	3	3	3
STD.DEV.	0.32	0.46	2.57	.23	.03
90% C.I.	0.54	0.77	4.33	.38	.06

TABLE B.5.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 1000 FT.FLYOVER (0.9*VH)/TARGET IAS=125 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
E58	76.9	67.7	19	7.2	.4
E59	76.2	66.8	16	7.8	.5
E60	76.8	67	19	7.7	.5
AVERAGE	76.60	67.20	18.00	7.60	.5
N	3	3	3	3	3
STD.DEV.	0.38	0.47	1.73	.32	.05
90% C.I.	0.64	0.80	2.92	.54	.08

TABLE B.6.1

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=62 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
F1	90.7	83	12	7.1	.5
F2	90.4	83.1	10	7.3	.5
F3	92	84.1	13	7.1	.5
F4	90.5	82.9	10	7.6	.6
F5	89.5	82.7	10	6.8	.5
F6	89.4	81.4	11	7.7	.6
AVERAGE	90.40	82.90	11.00	7.30	.5
N	6	6	6	6	6
STD.DEV.	0.95	0.87	1.26	.33	.05
90% C.I.	0.78	0.71	1.04	.27	.04

TABLE B.6.2

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=62 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
F1	89	80.9	12	7.5	.5
F2	86.3	78.5	13	7	.5
F3	90.1	83.2	10	6.9	.5
F4	88.4	80.2	13	7.4	.5
F5	86.1	79.2	10	6.9	.5
F6	88.7	82.3	9	6.7	.5
AVERAGE	88.10	80.70	11.20	7.10	.5
N	6	6	6	6	6
STD.DEV.	1.58	1.80	1.72	.31	.03
90% C.I.	1.30	1.48	1.42	.25	.02

TABLE B.6.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=62 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
F1	89.2	80.8	13	7.5	.5
F2	86.6	78.6	13	7.2	.5
F3	88.5	80.1	15	7.1	.5
F4	88.9	82.2	9	7	.5
F5	86	77	14	7.9	.6
F6	87.2	79.1	13	7.3	.5
AVERAGE	87.70	79.60	12.80	7.30	.5
N	6	6	6	6	6
STD.DEV.	1.32	1.81	2.04	.31	.04
90% C.I.	1.08	1.49	1.68	.25	.03

TABLE B.7.1

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=72 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
G7	90.4	84.2	11	6	.4
G8	91.5	85.2	13	5.7	.3
G9	87.8	81.7	11	5.9	.4
G10	89.9	81.8	14	7.1	.5
G11	89.3	82.8	13	5.8	.3
AVERAGE	89.80	83.10	12.40	6.10	.4
N	5	5	5	5	5
STD.DEV.	1.37	1.53	1.34	.57	.05
90% C.I.	1.31	1.46	1.28	.54	.05

TABLE B.7.2

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=72 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
G7	89.8	84.4	8	6	.4
G8	87.8	80.7	10	7.1	.5
G9	85.9	79.2	10	6.7	.5
G10	89.7	82.6	11	6.8	.5
G11	88.8	81.7	10	7.1	.5
AVERAGE	88.40	81.70	9.80	6.70	.5
N	5	5	5	5	5
STD.DEV.	1.61	1.96	1.10	.46	.03
90% C.I.	1.54	1.87	1.04	.44	.03

TABLE B.7.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=72 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
G7	86.4	78.9	11	7.2	.5
G8	84.8	76.7	13	7.3	.5
G9	85.6	77.4	11	7.9	.6
G10	88.2	80.5	14	6.7	.4
G11	87.8	79.6	13	7.4	.5
AVERAGE	86.60	78.60	12.40	7.30	.5
N	5	5	5	5	5
STD.DEV.	1.44	1.56	1.34	.41	.06
90% C.I.	1.37	1.49	1.28	.39	.06

TABLE B.8.1

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=52 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
H12	91.1	82.2	15	7.6	.5
H13	93.3	85.8	12	6.9	.5
H14	90.6	84.4	11	6	.4
H15	91.9	83.5	12	7.8	.6
H16	93.3	86.9	9	6.7	.5
AVERAGE	92.00	84.60	11.80	7.00	.5
N	5	5	5	5	5
STD.DEV.	1.24	1.85	2.17	.73	.07
90% C.I.	1.18	1.77	2.07	.69	.07

TABLE B.8.2

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=52 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
H12	88	80.4	12	7	.5
H13	91.3	82.9	15	7.1	.5
H14	88.2	79.8	16	7	.4
H15	88.8	79.3	18	7.6	.5
H16	91.4	83.6	12	7.2	.5
AVERAGE	89.50	81.20	14.60	7.20	.5
N	5	5	5	5	5
STD.DEV.	1.68	1.93	2.61	.23	.03
90% C.I.	1.60	1.84	2.49	.22	.03

TABLE B.8.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=52 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
H12	87	78.1	18	7.1	.4
H13	90.6	81.7	19	7	.4
H14	88.1	79.2	15	7.6	.5
H15	87	77.2	21	7.4	.5
H16	90.5	80.2	20	7.9	.5
AVERAGE	88.60	79.30	18.60	7.40	.5
N	5	5	5	5	5
STD.DEV.	1.80	1.76	2.30	.38	.06
90% C.I.	1.72	1.68	2.19	.36	.05

TABLE B.9.1

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: ICAO TAKEOFF

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
I17	86.8	79.8	10	7	.5
I18	86.8	78.9	11.5	7.4	.5
I19	86.5	78.8	11	7.4	.5
I20	86.2	79.1	11	6.8	.5
I21	86.3	79.2	10	7.1	.5
I22	86	78.8	11	6.9	.5
AVERAGE	86.40	79.10	10.80	7.10	.5
N	6	6	6	6	6
STD.DEV.	0.33	0.38	0.61	.26	.03
90% C.I.	0.27	0.31	0.50	.21	.02

TABLE B.9.2

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: ICAO TAKEOFF

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
I17	82.9	74.5	13	7.5	.5
I18	83.3	75.4	12	7.3	.5
I19	82.7	73.9	15	7.5	.5
I20	84	75.3	14	7.6	.5
I21	83.6	74.8	13	7.9	.6
I22	83.2	74.1	17	7.4	.5
AVERAGE	83.30	74.70	14.00	7.50	.5
N	6	6	6	6	6
STD.DEV.	0.47	0.62	1.79	.2	.04
90% C.I.	0.39	0.51	1.47	.17	.03

TABLE B.9.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: ICAO TAKEOFF

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
I17	82	73.2	14	7.7	.5
I18	82.5	73.1	16	7.8	.5
I19	82.1	72.9	16	7.6	.5
I20	82.6	72.3	20	7.9	.5
I21	82.8	72.1	22	8	.5
I22	82.5	72.9	16	8	.6
AVERAGE	82.40	72.80	17.30	7.80	.5
N	6	6	6	6	6
STD.DEV.	0.31	0.45	3.01	.15	.02
90% C.I.	0.25	0.37	2.48	.12	.01

TABLE B.10.1

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 9 DEGREE APPROACH/TARGET IAS=62 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
J23	NA	NA	9	NA	NA
J24	92.1	86	8	6.8	.5
J25	89.4	82.6	10	6.8	.5
J26	87.3	80.4	10	6.9	.5
AVERAGE	89.60	83.00	9.30	6.80	.5
N	3	3	4	3	3
STD.DEV.	2.41	2.82	0.96	.07	.02
90% C.I.	4.06	4.76	1.13	.13	.03

TABLE B.10.2

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 9 DEGREE APPROACH/TARGET IAS=62 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
J23	84.6	76.4	13	7.4	.5
J24	86.4	77.8	15.5	7.2	.5
J25	85.6	77	14	7.5	.5
J26	86.1	77.7	14	7.3	.5
AVERAGE	85.70	77.20	14.10	7.40	.5
N	4	4	4	4	4
STD.DEV.	0.79	0.66	1.03	.12	.02
90% C.I.	0.93	0.77	1.21	.14	.03

TABLE B.10.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 9 DEGREE APPROACH/TARGET IAS=62 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
J23	84	75.1	16	7.4	.5
J24	84.6	75.5	15	7.7	.5
J25	83.9	75.7	13	7.4	.5
J26	85.9	76.6	17	7.6	.5
AVERAGE	84.60	75.70	15.30	7.50	.5
N	4	4	4	4	4
STD.DEV.	0.92	0.63	1.71	.17	.02
90% C.I.	1.08	0.75	2.01	.2	.03

TABLE B.11.1

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: STANDARD TAKEOFF

MIC SITE 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
K27	85.4	78.8	8	7.3	.6
K28	86.3	79.9	8.5	6.9	.5
K29	86.6	79.1	11	7.2	.5
K30	85.8	78.6	10	7.2	.5
K31	86.7	80.6	8	6.8	.5
K32	82.2	79.3	10	2.9	.2
AVERAGE	85.50	79.40	9.30	6.40	.5
N	6	6	6	6	6
STD.DEV.	1.69	0.75	1.25	1.72	.14
90% C.I.	1.39	0.61	1.03	1.41	.11

TABLE B.11.2

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: STANDARD TAKEOFF

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
K27	83.6	76.3	10	7.3	.5
K28	83.8	75.2	13	7.7	.6
K29	83.5	74.5	15	7.7	.5
K30	83.2	75	12	7.6	.6
K31	84.2	76.1	11.5	7.6	.6
K32	83.4	74.1	15	7.9	.6
AVERAGE	83.60	75.20	12.80	7.60	.6
N	6	6	6	6	6
STD.DEV.	0.35	0.87	1.99	.2	.01
90% C.I.	0.29	0.71	1.64	.16	.01

TABLE B.11.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: STANDARD TAKEOFF

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
K27	82.1	73.9	13	7.4	.5
K28	82.2	73.9	14	7.2	.5
K29	81.7	72.8	16	7.4	.5
K30	82.1	72.7	16	7.8	.5
K31	82.2	72.4	17	8	.6
K32	81.6	72.6	16	7.5	.5
AVERAGE	82.00	73.10	15.30	7.50	.5
N	6	6	6	6	6
STD.DEV.	0.26	0.67	1.51	.28	.03
90% C.I.	0.22	0.55	1.24	.23	.03

TABLE B.12.1

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 12 DEGREE APPROACH/TARGET IAS=62 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
L33	87.3	80.4	10	6.9	.5
L34	87.5	80.9	9	6.9	.5
L35	87.1	80.2	10	6.9	.5
L36	91.8	85.6	9	6.5	.5
L37	90.3	84.3	9	6.3	.4
AVERAGE	88.80	82.30	9.40	6.70	.5
N	5	5	5	5	5
STD.DEV.	2.13	2.49	0.55	.29	.03
90% C.I.	2.03	2.38	0.52	.28	.02

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: STANDARD TAKEOFF

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
K27	82.1	73.9	13	7.4	.5
K28	82.2	73.9	14	7.2	.5
K29	81.7	72.8	16	7.4	.5
K30	82.1	72.7	16	7.8	.5
K31	82.2	72.4	17	8	.6
K32	81.6	72.6	16	7.5	.5
AVERAGE	82.00	73.10	15.30	7.50	.5
N	6	6	6	6	6
STD.DEV.	0.26	0.67	1.51	.28	.03
90% C.I.	0.22	0.55	1.24	.23	.03

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 12 DEGEE APPROACH/TARGET IAS=62 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
L33	87.3	80.4	10	6.9	.5
L34	87.5	80.9	9	6.9	.5
L35	87.1	80.2	10	6.9	.5
L36	91.8	85.6	9	6.5	.5
L37	90.3	84.3	9	6.3	.4
AVERAGE	88.80	82.30	9.40	6.70	.5
N	5	5	5	5	5
STD.DEV.	2.13	2.49	0.55	.29	.03
90% C.I.	2.03	2.38	0.52	.28	.02

TABLE B.12.2

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 12 DEGREE APPROACH/TARGET IAS=62 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
L33	84.8	76.5	12	7.7	.6
L34	85	76.2	13	7.9	.6
L35	84.3	76.6	11.5	7.3	.5
L36	89.6	81.6	13	7.2	.5
L37	85.3	76.1	16	7.6	.5
AVERAGE	85.80	77.40	13.10	7.50	.5
N	5	5	5	5	5
STD.DEV.	2.16	2.36	1.75	.3	.04
90% C.I.	2.05	2.25	1.66	.29	.04

TABLE B.12.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 12 DEGREE APPROACH/TARGET IAS=62 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
L33	83.5	74.3	15	7.8	.6
L34	85.3	75.8	19	7.4	.5
L35	83.5	74.2	19	7.3	.5
L36	89	81.7	10	7.3	.5
L37	84.8	74.7	19	7.9	.5
AVERAGE	85.20	76.10	16.40	7.50	.5
N	5	5	5	5	5
STD.DEV.	2.26	3.17	3.97	.3	.05
90% C.I.	2.15	3.02	3.79	.28	.04

APPENDIX C

Magnetic Recording Acoustical Data for Static Operations

This appendix contains time average, A-weighted sound level data along with time average, 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.

TABLE NO. C.6-1H.1

HUGHES 500D HELICOPTER

DOT/TSC
4/24/84

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

SITE: 1H (SOFT) - 150 M. NW JUNE 22,1983

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	42.7	43.3	45.7	44.1	46.2	43.9	43.1	44.7	44.4	-0.3	44.2	1.2
15	50.8	53.3	51.7	52.4	52.1	51.5	49.6	51.9	51.8	12.4	51.7	1.1
16	70.1	73.4	70.2	71.0	70.3	69.7	66.3	71.3	70.7	36.1	70.3	2.0
17	56.0	58.2	56.5	57.8	58.0	57.3	54.0	57.2	57.0	26.8	56.9	1.4
18	56.0	55.3	56.4	59.3	59.9	59.6	56.4	58.9	58.1	31.9	57.7	1.9
19	64.0	64.0	64.4	66.4	67.3	66.5	65.3	66.7	65.7	43.2	65.6	1.3
20	60.9	60.9	64.3	66.2	67.1	66.7	64.2	61.5	64.6	45.5	64.0	2.6
21	67.8	68.5	72.2	73.4	74.8	74.0	72.4	67.0	72.1	56.0	71.3	3.0
22	65.5	66.5	71.1	71.1	72.1	71.4	69.4	66.4	69.8	56.4	69.2	2.7
23	55.4	57.8	63.0	64.2	65.7	65.6	63.9	60.2	63.1	52.2	62.0	3.8
24	48.6	51.2	55.4	55.8	59.2	56.3	55.4	53.6	55.4	46.8	54.4	3.3
25	37.9	39.9	43.8	45.5	48.7	47.1	43.6	41.9	44.8	38.2	43.5	3.6
26	34.2	35.8	43.8	46.2	47.4	46.8	42.6	42.1	44.2	39.4	42.4	5.0
27	38.7	40.6	45.8	47.9	51.4	51.6	46.2	45.8	47.8	44.6	46.0	4.6
28	41.6	44.1	48.2	51.2	55.9	55.7	49.8	49.7	51.7	49.8	49.5	5.0
29	44.1	46.8	49.3	52.4	58.9	59.2	51.6	52.7	54.5	53.7	51.9	5.3
30	47.1	48.7	49.8	52.3	60.1	60.6	52.4	54.1	55.7	55.7	53.1	5.0
31	46.7	49.4	50.2	52.0	60.2	60.2	52.1	55.0	55.7	56.3	53.2	4.9
32	46.5	49.9	48.7	51.2	60.4	60.1	51.5	53.1	55.5	56.5	52.7	5.1
33	47.3	50.0	50.0	50.8	60.2	60.0	52.0	53.1	55.4	56.6	52.9	4.7
34	46.4	49.6	49.3	49.7	59.0	58.7	50.9	51.7	54.2	55.5	51.9	4.5
35	45.9	49.0	48.6	48.1	57.3	57.0	49.0	50.7	52.7	53.9	50.7	4.2
36	44.7	48.6	47.1	46.2	54.9	54.4	46.9	49.2	50.6	51.6	49.0	3.8
37	43.0	47.5	45.9	44.5	51.4	50.8	44.4	47.4	47.8	48.3	46.9	3.0
38	41.9	46.6	44.1	43.1	48.7	47.6	42.0	46.0	45.7	45.6	45.0	2.6
39	38.4	43.2	40.2	39.9	43.9	42.8	37.8	42.2	41.5	40.4	41.0	2.3
40	34.5	39.2	36.3	35.9	38.8	37.1	33.3	37.5	37.0	34.5	36.6	2.0
AL	59.3	61.6	63.4	64.4	70.2	70.0	63.9	63.9	66.1	66.1	64.6	3.8
OASPL	74.0	76.0	77.0	77.9	79.1	78.5	76.2	75.2	77.0	-	76.7	1.7
PNL	73.3	75.4	78.0	79.0	83.4	83.0	78.1	77.1	79.5	-	78.4	3.5
PNLT	74.3	76.4	78.8	79.8	84.3	83.8	79.0	78.2	80.3	-	79.3	3.4

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.6-1H.2

HUGHES 500D HELICOPTER

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 1H (SOFT) - 150 M. NW JUNE 22,1983

FLIGHT IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	39.2	40.7	42.2	43.8	41.3	43.7	44.9	42.5	42.6	-2.1	42.3	1.9
15	49.5	49.5	50.3	48.9	49.2	49.8	51.6	50.0	49.9	10.5	49.8	0.8
16	69.3	68.6	69.5	67.6	69.0	69.4	71.1	69.7	69.4	34.8	69.3	1.0
17	53.6	53.7	53.8	52.5	53.6	54.0	55.5	54.2	53.9	23.7	53.9	0.8
18	52.3	54.2	52.1	53.0	53.0	52.5	52.2	53.2	52.9	26.7	52.8	0.7
19	63.1	63.4	64.2	63.6	63.0	62.3	62.0	63.9	63.2	40.7	63.2	0.9
20	63.2	63.9	64.9	66.7	66.0	65.8	64.6	63.2	65.0	45.9	64.8	1.3
21	68.0	68.0	71.3	72.6	71.0	71.2	69.7	67.4	70.3	54.2	69.9	1.9
22	63.4	63.8	65.5	66.1	64.2	63.7	65.8	63.3	64.6	51.2	64.5	1.1
23	53.3	55.3	56.5	57.3	54.9	55.7	56.0	55.5	55.7	44.8	55.6	1.2
24	47.1	50.2	52.5	54.4	49.9	51.9	52.9	51.2	51.7	43.1	51.3	2.2
25	36.5	41.7	41.9	43.1	40.0	42.6	42.2	40.8	41.5	34.9	41.1	2.1
26	33.1	33.9	39.3	42.8	37.3	37.0	34.5	34.3	37.8	33.0	36.5	3.3
27	37.0	38.6	44.9	47.1	43.8	41.6	38.0	39.8	42.7	39.5	41.3	3.6
28	39.2	41.0	48.1	48.8	47.3	43.0	39.0	41.1	45.0	43.1	43.4	4.0
29	40.5	41.3	50.5	50.5	49.9	43.3	39.8	44.1	47.0	46.2	45.0	4.6
30	40.7	40.4	50.6	50.7	49.6	44.0	40.5	43.9	47.1	47.1	45.0	4.6
31	40.7	40.5	50.4	49.9	48.6	43.5	40.0	43.3	46.5	47.1	44.6	4.4
32	42.3	41.8	52.4	50.4	48.9	42.0	39.6	42.8	47.4	48.4	45.0	4.8
33	42.7	38.2	53.1	50.5	49.3	40.7	39.5	42.3	47.6	48.8	44.5	5.6
34	41.9	37.8	52.5	48.8	47.2	39.5	38.3	41.3	46.5	47.8	43.4	5.4
35	41.7	36.4	52.5	47.8	46.0	38.4	37.4	40.8	46.0	47.2	42.6	5.7
36	41.1	34.9	51.1	46.5	45.0	37.7	36.5	39.7	44.8	45.8	41.6	5.6
37	40.0	33.9	49.5	44.0	41.9	35.5	36.9	37.6	42.9	43.4	39.9	5.1
38	39.9	35.0	45.7	41.1	40.1	34.4	35.0	36.9	40.2	40.1	38.5	3.9
39	38.0	33.9	40.5	37.2	36.7	31.5	30.8	34.8	36.5	35.4	35.4	3.3
40	35.7	27.5	37.2	33.1	32.2	26.9	--	29.0	33.2	30.7	31.7	4.0
AL	56.9	56.6	63.6	62.5	61.0	58.5	57.8	57.1	60.0	60.0	59.2	2.7
OASPL	73.4	73.4	75.3	75.7	74.9	74.9	75.0	73.6	74.6	--	74.5	0.9
PNL	71.8	71.1	77.6	77.3	75.5	73.5	72.2	71.6	74.8	--	73.8	2.6
PNLT	72.6	71.8	78.6	78.4	76.5	74.6	73.0	72.6	75.8	--	74.8	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.6-1H.3

HUGHES 500D HELICOPTER

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 1H (SOFT) - 150 M. NW JUNE 22,1983

GROUND IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	43.5	40.6	48.4	42.8	47.5	44.9	49.8	42.6	46.1	1.4	45.0	3.2
15	40.0	40.0	43.3	42.2	42.6	40.3	42.8	39.3	41.6	2.2	41.3	1.6
16	43.6	45.5	45.3	44.1	41.4	42.6	44.5	43.6	44.0	9.4	43.8	1.4
17	45.5	47.3	47.9	47.4	47.8	49.9	48.6	49.0	48.1	17.9	47.9	1.3
18	46.3	47.4	49.9	48.2	47.2	47.7	48.2	47.3	47.9	21.7	47.8	1.1
19	51.7	53.6	58.2	55.3	53.6	55.5	54.8	53.3	54.9	32.4	54.5	1.9
20	62.6	61.7	62.8	65.7	64.3	65.5	63.8	62.1	63.8	44.7	63.6	1.5
21	65.1	62.8	65.9	69.2	67.7	68.0	65.0	63.8	66.4	50.3	65.9	2.2
22	51.4	51.2	54.9	57.7	54.4	57.1	57.0	53.5	55.3	41.9	54.6	2.5
23	45.7	48.9	53.5	51.8	47.5	52.8	51.5	49.7	50.8	39.9	50.2	2.7
24	40.9	43.6	49.0	49.4	42.8	49.5	48.0	46.5	47.2	38.6	46.2	3.4
25	33.7	36.5	37.9	40.1	33.6	38.1	37.7	35.4	37.1	30.5	36.6	2.3
26	30.1	33.0	33.1	33.9	30.8	33.0	32.9	31.5	32.5	27.7	32.3	1.3
27	29.3	31.8	33.8	40.3	28.8	32.9	33.7	30.4	34.3	31.1	32.6	3.6
28	30.8	33.3	34.9	39.4	29.8	33.7	33.8	31.8	34.5	32.6	33.4	2.9
29	30.6	31.0	32.4	37.4	30.4	35.5	33.7	34.8	33.9	33.1	33.2	2.6
30	28.5	31.2	34.0	36.7	29.7	36.4	33.5	32.7	33.7	33.7	32.8	2.9
31	35.0	33.8	40.5	38.7	31.5	37.9	34.5	33.0	36.6	37.2	35.6	3.1
32	27.4	31.6	31.0	38.1	33.1	37.9	33.5	33.3	34.5	35.5	33.2	3.5
33	26.1	30.0	-	35.8	30.3	36.8	33.1	30.7	33.1	34.3	31.8	3.7
34	29.4	30.3	-	35.0	29.8	36.3	33.1	30.8	32.9	34.2	32.1	2.7
35	29.2	28.3	-	36.0	29.7	36.7	32.5	30.0	33.0	34.2	31.8	3.4
36	27.5	-	-	34.6	32.0	34.3	-	29.3	32.3	33.3	31.5	3.1
37	-	-	-	32.0	31.3	-	-	-	31.7	32.2	31.6	0.5
38	-	-	-	30.6	25.9	-	-	-	28.9	28.8	28.2	3.3
39	-	-	-	35.9	28.6	-	-	-	33.6	32.5	32.2	5.2
40	-	-	-	32.7	27.6	-	-	-	30.9	28.4	30.1	3.6
AL	51.3	50.1	53.0	55.6	53.3	54.9	52.5	51.1	53.1	53.1	52.7	1.9
OASPL	67.4	66.1	68.7	71.3	69.7	70.5	68.4	66.8	68.9	-	68.6	1.8
PNL	65.0	64.0	66.9	70.5	67.2	69.6	66.6	65.2	67.6	-	66.9	2.2
PNLT	67.4	65.8	69.6	71.8	68.6	70.7	67.3	66.4	68.7	-	68.4	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 NO. C.6-2H.1

HUGHES 500D HELICOPTER

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 2 (SOFT) - 150 M. WEST JUNE 22,1983

HOVER-IN-GROUND-EFFECT

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	46.5	49.2	49.2	52.0	48.9	48.7	48.7	48.0	49.2	4.5	48.9	1.5
15	54.4	57.5	55.8	57.2	55.8	55.5	52.1	55.4	55.7	16.3	55.5	1.7
16	73.3	76.3	73.9	75.0	73.7	72.4	68.2	74.5	73.9	39.3	73.4	2.4
17	58.8	61.0	60.0	61.7	61.1	60.0	57.7	59.6	60.2	30.0	60.0	1.3
18	57.3	56.8	58.7	62.0	62.9	61.3	59.2	59.8	60.2	34.0	59.7	2.2
19	66.5	66.3	67.6	69.6	69.7	68.6	68.3	68.1	68.2	45.7	68.1	1.3
20	63.0	64.0	67.1	69.4	69.5	69.3	66.6	62.8	67.2	48.1	66.5	2.9
21	69.1	70.3	73.4	76.4	76.9	77.1	74.1	69.1	74.4	58.3	73.3	3.4
22	67.2	70.1	72.8	74.7	74.2	74.3	71.2	66.9	72.3	58.9	71.4	3.1
23	56.6	63.3	65.7	68.8	68.6	69.1	65.7	61.6	66.3	55.4	64.9	4.3
24	50.4	55.2	55.8	59.3	60.7	57.7	56.0	54.4	57.1	48.5	56.2	3.2
25	37.7	42.1	43.8	48.0	48.6	49.5	45.6	42.9	46.1	39.5	44.8	4.0
26	34.6	42.2	44.6	49.5	49.4	52.7	44.5	41.5	47.5	42.7	44.9	5.7
27	39.1	47.1	48.3	51.3	55.1	57.8	47.4	43.7	52.0	48.8	48.7	6.0
28	44.4	51.7	52.1	56.0	61.1	62.9	51.7	49.2	57.2	55.3	53.6	6.1
29	47.8	53.7	54.5	58.4	62.9	66.3	52.2	52.3	59.9	59.1	56.0	6.1
30	50.6	55.2	56.5	59.1	64.6	67.5	53.8	54.1	61.3	61.3	57.7	5.8
31	50.1	55.4	57.1	59.3	64.6	67.7	54.0	55.4	61.5	62.1	57.9	5.8
32	51.0	56.5	55.5	59.2	65.0	68.0	53.9	55.2	61.7	62.7	58.0	5.8
33	52.6	56.8	57.5	59.7	66.0	68.3	54.5	55.0	62.3	63.5	58.8	5.6
34	51.9	56.8	56.7	59.0	64.7	66.7	54.1	54.3	61.0	62.3	58.0	5.2
35	50.6	55.4	54.9	56.8	61.9	64.0	52.8	52.9	58.5	59.7	56.2	4.6
36	48.5	53.6	52.6	54.1	58.7	60.4	50.5	51.1	55.5	56.5	53.7	4.1
37	44.8	50.7	50.6	51.0	54.3	56.2	48.5	48.3	51.8	52.3	50.5	3.6
38	41.9	48.1	48.2	48.0	50.8	52.7	45.9	45.7	48.7	48.6	47.7	3.3
39	38.4	44.8	43.6	44.6	46.6	48.8	42.1	42.1	44.8	43.7	43.9	3.1
40	34.1	39.5	38.5	39.3	--	42.3	36.9	36.5	38.8	36.3	38.2	2.6
AL	62.4	66.9	67.8	70.3	74.6	76.9	66.1	65.1	71.3	71.3	68.8	4.9
OASPL	76.5	78.9	79.4	81.5	81.8	82.1	78.1	77.5	79.9	--	79.5	2.1
PNL	76.0	80.7	81.6	84.1	87.8	89.6	80.5	78.7	84.6	--	82.4	4.6
PNLT	77.0	81.7	82.4	84.8	88.7	90.5	81.4	79.9	85.3	--	83.3	4.5

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.6-2H.2

HUGHES 500D HELICOPTER

DOT/TSC
4/24/84

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

SITE: 2 (SOFT) - 150 M. WEST JUNE 22,1983

FLIGHT IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	44.7	47.0	46.7	45.7	48.9	-	46.1	-	46.7	2.0	46.5	1.4
15	53.9	54.0	54.5	52.6	53.8	-	55.5	-	54.1	14.7	54.0	0.9
16	73.0	72.4	73.2	71.6	72.5	-	74.9	-	73.1	38.5	72.9	1.1
17	57.2	56.7	57.5	56.7	57.3	-	59.1	-	57.5	27.3	57.4	0.9
18	54.9	53.8	55.7	55.9	55.4	-	57.1	-	55.6	29.4	55.5	1.1
19	66.0	64.4	67.7	66.6	66.4	-	64.5	-	66.1	43.6	65.9	1.3
20	66.1	67.9	67.4	70.1	69.0	-	67.4	-	68.2	49.1	68.0	1.4
21	70.7	72.0	73.9	75.5	73.6	-	72.7	-	73.3	57.2	73.1	1.7
22	65.7	67.3	68.9	68.9	67.5	-	68.5	-	67.9	54.5	67.8	1.2
23	55.4	57.5	61.9	61.5	56.1	-	60.1	-	59.5	48.6	58.7	2.8
24	49.4	52.4	55.1	55.4	51.3	-	55.0	-	53.6	45.0	53.1	2.5
25	39.4	40.9	42.7	43.2	40.2	-	43.0	-	41.8	35.2	41.6	1.6
26	34.6	39.6	43.7	45.4	35.5	-	38.2	-	41.3	36.5	39.5	4.3
27	39.8	46.1	50.6	50.6	42.4	-	44.0	-	47.3	44.1	45.6	4.4
28	43.5	50.3	56.3	55.2	47.1	-	48.5	-	52.3	50.4	50.1	4.9
29	49.4	53.3	59.8	57.9	50.0	-	51.2	-	55.4	54.6	53.6	4.3
30	49.8	55.0	61.4	59.0	51.0	-	53.5	-	56.9	56.9	54.9	4.5
31	50.8	57.0	62.0	58.8	51.9	-	54.5	-	57.5	58.1	55.8	4.3
32	53.3	59.1	63.6	59.7	54.3	-	55.0	-	59.1	60.1	57.5	4.0
33	53.9	59.2	63.7	60.8	55.7	-	55.7	-	59.5	60.7	58.2	3.7
34	53.3	59.5	61.7	59.7	55.5	-	55.5	-	58.5	59.8	57.5	3.2
35	53.3	58.8	58.7	58.2	56.0	-	54.8	-	57.1	58.3	56.6	2.3
36	52.9	55.6	53.9	56.0	54.7	-	53.1	-	54.5	55.5	54.4	1.3
37	52.0	53.1	52.4	54.0	51.3	-	54.8	-	53.1	53.6	52.9	1.3
38	51.5	51.5	48.7	51.3	50.4	-	50.4	-	50.7	50.6	50.6	1.1
39	49.7	50.9	44.5	48.3	49.2	-	45.1	-	48.5	47.4	47.9	2.6
40	46.4	41.9	40.8	41.7	43.4	-	40.2	-	42.9	40.4	42.4	2.2
AL	64.4	68.6	71.8	70.0	66.0	-	66.3	-	68.6	68.6	67.8	2.8
OASPL	76.7	77.4	79.0	79.2	78.0	-	78.5	-	78.2	-	78.1	1.0
PNL	78.5	82.5	84.5	83.5	80.3	-	80.2	-	82.2	-	81.6	2.3
PNLT	79.4	83.2	85.5	84.5	81.2	-	81.2	-	83.1	-	82.5	2.3

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.6-2H.3

HUGHES 500D HELICOPTER

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 2 (SOFT) - 150 M. WEST JUNE 22,1983

GROUND IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	47.1	48.0	54.8	48.5	50.7	51.4	55.4	48.3	51.6	6.9	50.5	3.2
15	43.9	47.1	45.4	45.9	44.0	48.3	44.8	44.3	45.7	6.3	45.5	1.6
16	48.3	48.8	48.0	46.9	45.0	48.5	47.7	46.3	47.6	13.0	47.4	1.3
17	47.3	49.9	54.7	51.6	51.8	51.7	54.2	48.9	51.9	21.7	51.3	2.5
18	49.3	51.4	51.0	50.7	50.0	50.2	52.4	48.1	50.6	24.4	50.4	1.3
19	55.2	60.2	58.6	58.4	57.7	57.7	59.0	55.7	58.1	35.6	57.8	1.7
20	64.5	65.9	67.0	68.9	67.7	67.8	66.9	65.3	67.0	47.9	66.7	1.4
21	65.9	67.4	70.0	71.4	70.1	69.2	68.7	67.1	69.0	52.9	68.7	1.8
22	52.8	57.1	60.5	61.9	58.1	58.3	60.1	56.4	58.9	45.5	58.1	2.8
23	48.0	54.2	55.4	55.2	51.1	54.8	54.5	52.0	53.7	42.8	53.1	2.6
24	42.7	48.2	52.1	51.4	45.2	50.1	49.9	47.6	49.3	40.7	48.4	3.2
25	35.8	36.1	38.0	39.9	33.7	38.2	37.3	35.4	37.2	30.6	36.8	1.9
26	33.1	33.2	34.2	36.9	31.1	34.0	33.2	33.0	33.9	29.1	33.6	1.6
27	31.9	33.6	38.0	39.9	30.1	37.3	34.5	34.1	36.0	32.8	34.9	3.3
28	36.7	38.1	41.2	42.1	36.0	40.9	38.1	40.7	39.7	37.8	39.2	2.3
29	32.4	38.0	42.4	44.5	39.2	43.9	40.6	41.9	41.5	40.7	40.4	3.9
30	36.8	40.4	44.0	44.7	40.5	45.6	43.0	42.4	42.9	42.9	42.2	2.9
31	40.0	45.6	46.4	47.3	45.3	48.4	47.1	44.9	46.1	46.7	45.6	2.6
32	39.4	42.2	45.9	47.9	46.1	48.7	46.3	47.2	46.2	47.2	45.5	3.1
33	37.8	43.3	46.1	48.5	44.7	48.3	46.0	44.3	45.8	47.0	44.9	3.4
34	39.5	44.1	46.1	48.9	44.9	47.6	46.2	44.7	45.9	47.2	45.2	2.8
35	39.1	44.1	48.7	52.9	44.7	48.0	48.2	44.5	47.9	49.1	46.3	4.1
36	37.9	41.4	45.4	48.7	41.9	45.1	44.9	43.2	44.6	45.6	43.6	3.2
37	36.8	38.9	42.6	45.1	39.2	43.1	42.3	41.7	41.9	42.4	41.2	2.7
38	39.2	37.0	40.4	42.5	37.0	41.4	40.7	41.6	40.4	40.3	40.0	2.1
39	53.6	44.8	42.2	43.0	39.4	39.9	42.2	47.3	46.8	45.7	44.0	4.6
40	42.8	36.3	39.8	42.5	36.5	38.2	40.6	42.6	40.6	38.1	39.9	2.7
AL	56.3	56.8	59.4	61.4	58.1	59.7	58.8	57.6	58.8	58.8	58.5	1.7
OASPL	69.0	70.7	72.7	74.1	72.6	72.3	72.0	70.1	71.9	-	71.7	1.6
PNL	70.4	71.6	74.4	76.3	73.0	74.1	73.5	72.1	73.6	-	73.2	1.8
PNLT	72.5	73.0	75.4	77.6	74.2	75.1	74.4	73.1	74.7	-	74.4	1.6

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.6-4H.1

HUGHES 500D HELICOPTER

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 4H (SOFT) - 300 M. WEST JUNE 22,1983

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	40.9	44.9	44.5	54.7	42.4	42.8	43.3	41.5	47.4	2.7	44.4	4.4
15	49.1	52.7	50.6	55.0	50.5	50.3	47.5	49.5	51.2	11.8	50.6	2.3
16	65.3	68.4	64.4	66.4	65.8	63.7	59.9	65.6	65.5	30.9	64.9	2.5
17	49.2	51.0	50.5	57.4	52.7	51.2	50.7	50.3	52.5	22.3	51.6	2.5
18	50.6	50.1	51.0	57.9	55.5	54.1	52.5	53.6	53.9	27.7	53.2	2.7
19	56.3	57.1	57.6	60.8	61.0	59.5	59.1	57.8	59.0	36.5	58.6	1.7
20	55.7	56.5	59.4	61.5	61.7	61.1	59.3	54.5	59.4	40.3	58.7	2.8
21	60.2	61.3	64.6	66.8	67.4	67.3	65.0	59.1	64.9	48.8	64.0	3.3
22	55.1	57.6	61.2	62.7	62.6	62.7	60.5	54.7	60.6	47.2	59.6	3.4
23	43.3	47.3	50.3	54.0	52.7	52.8	51.1	46.0	50.9	40.0	49.7	3.8
24	31.8	36.9	40.0	47.9	42.8	41.4	38.3	34.5	41.8	33.2	39.2	5.0
25	30.1	37.5	39.5	44.1	41.0	42.2	39.7	35.1	40.2	33.6	38.6	4.4
26	29.3	36.5	36.6	47.2	41.9	44.4	37.5	33.6	41.5	36.7	38.4	5.8
27	29.3	37.2	38.4	48.1	43.9	46.9	39.9	34.5	43.1	39.9	39.8	6.4
28	33.8	41.2	40.8	50.0	48.5	52.8	44.6	40.4	47.3	45.4	44.0	6.2
29	38.2	45.4	43.3	50.5	53.0	58.4	47.0	44.3	51.6	50.8	47.5	6.3
30	42.2	48.0	44.9	50.6	55.0	60.7	49.9	47.2	53.7	53.7	49.8	5.8
31	41.9	48.9	45.1	49.8	55.2	61.5	49.7	47.4	54.2	54.8	49.9	6.1
32	43.7	50.2	44.9	49.3	54.5	62.3	50.8	48.0	54.8	55.8	50.5	5.9
33	45.3	50.3	47.0	48.8	53.9	61.8	51.2	48.6	54.5	55.7	50.9	5.1
34	45.1	50.1	46.6	47.2	52.7	59.9	50.5	48.0	52.9	54.2	50.0	4.7
35	43.6	48.0	44.2	44.4	49.9	56.4	47.4	46.0	49.8	51.0	47.5	4.2
36	41.2	45.3	41.3	41.4	47.5	52.7	43.7	43.2	46.5	47.5	44.5	4.0
37	36.2	41.7	38.3	37.9	43.2	47.1	40.2	39.0	41.8	42.3	40.4	3.5
38	31.7	37.1	34.1	33.9	37.9	41.7	36.2	34.6	37.0	36.9	35.9	3.1
39	-	30.7	27.8	28.9	-	34.8	29.8	29.7	30.9	29.8	30.3	2.4
40	-	-	-	-	-	24.0	-	-	24.0	21.5	24.0	-
AL	54.2	59.2	56.9	60.2	63.7	70.1	60.1	57.4	63.2	63.2	60.2	4.9
OASPL	67.8	70.4	69.6	72.2	72.2	73.2	69.1	68.1	70.7	-	70.3	2.0
PNL	67.4	72.2	70.1	73.1	76.0	81.4	73.1	70.2	75.5	-	72.9	4.3
PNLT	68.2	72.9	70.8	73.9	76.8	82.3	73.9	71.0	76.3	-	73.7	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.6-4H.2

HUGHES 500D HELICOPTER

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 4H (SOFT) - 300 M. WEST JUNE 22,1983

FLIGHT IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	38.1	41.2	38.0	38.9	45.7	44.1	42.5	38.3	41.8	-2.9	40.8	3.0
15	49.0	48.4	44.2	47.2	48.4	48.2	49.4	48.1	48.1	8.7	47.9	1.6
16	64.9	64.0	59.6	63.5	63.7	63.8	65.8	64.3	64.0	29.4	63.7	1.8
17	47.1	46.8	42.3	46.7	46.8	46.4	47.7	46.4	46.5	16.3	46.3	1.7
18	49.1	47.0	43.1	48.8	48.2	49.1	50.5	46.9	48.3	22.1	47.8	2.2
19	56.8	54.4	53.5	57.5	56.2	57.1	54.4	55.3	55.9	33.4	55.6	1.5
20	58.6	60.0	55.3	62.6	60.6	60.6	58.9	58.0	59.8	40.7	59.3	2.2
21	61.1	62.0	59.7	65.7	63.1	63.9	62.8	59.9	62.7	46.6	62.3	2.0
22	52.7	53.1	49.3	56.0	53.9	56.1	55.5	52.7	54.1	40.7	53.7	2.3
23	40.6	40.9	40.2	44.5	41.4	46.4	44.6	42.1	43.1	32.2	42.6	2.3
24	32.5	33.8	31.2	38.2	34.5	36.8	36.0	32.8	35.1	26.5	34.5	2.4
25	33.1	34.8	32.7	40.6	32.9	35.6	34.8	32.6	35.6	29.0	34.6	2.7
26	30.4	31.8	32.1	37.9	31.7	32.7	32.1	31.0	33.2	28.4	32.5	2.3
27	31.4	34.8	32.6	42.3	32.4	34.8	33.6	31.4	36.0	32.8	34.2	3.5
28	34.9	40.8	38.9	47.8	37.7	38.2	38.4	36.3	41.3	39.4	39.1	3.9
29	36.2	46.3	48.4	51.9	42.7	41.6	41.9	39.6	46.1	45.3	43.6	5.0
30	35.9	50.0	51.4	53.5	45.4	44.6	43.8	42.5	48.5	48.5	45.9	5.6
31	36.0	53.4	52.2	53.8	47.4	46.3	44.9	45.8	50.0	50.6	47.5	5.9
32	39.7	55.6	53.9	55.0	51.0	46.7	46.2	46.6	51.7	52.7	49.3	5.5
33	38.8	55.1	53.3	54.9	51.5	46.4	47.0	47.0	51.5	52.7	49.2	5.5
34	38.4	53.4	52.1	53.2	50.8	46.0	46.7	47.1	50.3	51.6	48.5	5.0
35	38.0	49.0	48.9	49.9	48.9	44.6	45.3	45.2	47.3	48.5	46.2	3.9
36	37.1	43.9	45.2	46.4	45.0	43.9	43.3	43.9	44.2	45.2	43.6	2.8
37	34.9	39.9	43.2	42.3	39.7	42.0	43.1	41.3	41.4	41.9	40.8	2.7
38	32.6	37.2	36.4	37.4	36.0	38.6	35.5	38.3	36.8	36.7	36.5	1.9
39	-	31.6	28.5	31.7	32.1	31.6	26.8	33.1	31.2	30.1	30.8	2.2
40	-	-	-	-	-	-	-	-	-	-	-	-
AL	50.8	62.6	61.5	63.3	59.3	56.7	56.4	56.1	59.8	59.8	58.3	4.2
OASPL	67.8	68.6	65.7	70.3	68.5	68.7	68.9	67.3	68.4	-	68.2	1.3
PNL	64.6	74.1	73.0	75.3	72.1	69.7	69.5	69.3	72.3	-	70.9	3.4
PNLT	65.5	75.0	74.2	76.4	73.1	70.6	70.5	70.1	73.2	-	71.9	3.5

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.6-4H.3

HUGHES 500D HELICOPTER

DOT/TSC
4/24/84

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

SITE: 4H (SOFT) - 300 M. WEST JUNE 22,1983

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	40.3	44.1	47.9	41.1	41.7	46.9	46.3	40.6	44.6	-0.1	43.6	3.1
15	38.9	45.6	42.7	40.8	39.7	44.7	38.3	38.7	42.0	2.6	41.2	2.8
16	42.1	45.0	44.5	41.9	40.3	43.5	43.0	41.0	42.9	8.3	42.7	1.6
17	42.1	45.8	46.2	43.6	43.4	43.0	45.4	41.6	44.2	14.0	43.9	1.7
18	43.2	45.4	44.4	43.2	42.3	42.5	45.5	41.2	43.7	17.5	43.5	1.5
19	47.7	52.6	51.8	51.0	50.6	50.6	51.4	48.1	50.7	28.2	50.5	1.7
20	56.4	59.0	59.4	60.9	60.8	59.5	58.8	57.6	59.3	40.2	59.0	1.5
21	55.6	58.7	60.8	61.0	60.3	58.8	58.4	56.4	59.1	43.0	58.7	2.0
22	42.5	46.4	47.4	47.4	46.6	46.5	47.3	45.4	46.4	33.0	46.2	1.6
23	34.6	38.8	39.8	38.7	34.6	39.6	38.9	36.3	38.1	27.2	37.7	2.2
24	30.6	32.8	31.5	30.7	27.5	30.0	30.7	30.6	30.8	22.2	30.5	1.5
25	29.5	33.2	32.3	34.4	29.0	32.1	32.0	31.2	32.0	25.4	31.7	1.8
26	26.1	31.7	28.9	31.0	25.5	29.1	28.2	28.1	29.0	24.2	28.6	2.1
27	25.8	33.4	27.9	29.2	25.8	28.5	27.3	28.1	29.0	25.8	28.2	2.4
28	28.5	32.2	33.2	29.5	27.1	33.0	30.2	34.4	31.6	29.7	31.0	2.6
29	26.2	31.5	36.4	32.3	31.5	35.8	32.1	35.0	33.5	32.7	32.6	3.3
30	28.3	40.5	38.9	34.9	35.3	39.4	35.1	36.3	37.2	37.2	36.1	3.8
31	28.9	45.6	41.4	38.6	40.4	42.7	38.0	38.8	41.0	41.6	39.3	4.9
32	28.5	40.3	41.9	40.5	40.3	43.8	37.5	41.0	40.6	41.6	39.2	4.7
33	27.7	41.8	41.2	41.7	39.6	43.6	37.8	38.2	40.4	41.6	38.9	4.9
34	28.9	41.4	39.6	42.1	39.5	42.7	37.8	38.0	40.0	41.3	38.7	4.4
35	28.4	39.2	38.9	44.1	38.1	41.5	39.1	37.1	39.8	41.0	38.3	4.6
36	29.1	34.3	34.1	38.3	34.0	36.7	35.2	34.9	35.2	36.2	34.6	2.7
37	28.4	-	-	32.6	-	31.7	31.4	31.7	31.4	31.9	31.2	1.6
38	27.7	-	-	-	-	-	-	29.5	28.7	28.6	28.6	1.3
39	36.9	-	-	-	-	-	-	32.3	35.2	34.1	34.6	3.3
40	23.4	-	-	-	-	-	-	-	23.4	20.9	23.4	-
AL	44.6	52.0	51.4	52.2	50.5	52.6	49.3	49.4	50.8	50.8	50.2	2.6
OASPL	59.8	63.1	64.1	64.6	64.1	63.2	62.6	60.9	63.1	-	62.8	1.7
PNL	57.5	64.1	63.8	65.8	62.9	65.0	62.5	61.8	63.6	-	62.9	2.6
PNLT	59.3	66.1	65.1	67.1	63.9	65.9	63.4	62.8	65.1	-	64.2	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.6-5H.1

HUGHES 500D HELICOPTER

DOT/TSC
4/24/84

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

SITE: 5H (HARD) - 150 M. NORTH JUNE 22,1983

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	44.9	45.2	45.2	49.9	47.1	50.5	46.0	50.9	48.1	3.4	47.5	2.6
15	53.2	54.8	52.4	54.8	54.0	54.1	49.8	54.6	53.7	14.3	53.5	1.7
16	72.3	74.4	71.0	73.1	72.2	71.3	66.5	73.0	72.2	37.6	71.7	2.4
17	58.2	59.1	57.3	59.5	59.2	58.8	54.8	58.1	58.3	28.1	58.1	1.5
18	56.5	55.5	55.8	59.5	59.0	59.3	56.3	57.5	57.7	31.5	57.4	1.6
19	65.4	64.4	63.0	66.8	65.9	66.2	65.9	65.3	65.5	43.0	65.4	1.2
20	61.4	58.0	63.7	65.7	64.5	65.0	62.8	59.7	63.2	44.1	62.6	2.7
21	68.2	65.8	71.1	73.1	72.0	72.0	69.6	64.4	70.4	54.3	69.5	3.1
22	67.0	65.3	70.7	72.1	70.2	70.8	68.7	63.9	69.3	55.9	68.6	2.9
23	61.5	57.4	65.7	66.9	65.1	68.3	66.3	62.0	65.2	54.3	64.1	3.6
24	57.6	55.3	62.6	64.9	65.0	69.6	64.8	59.2	64.4	55.8	62.4	4.7
25	61.0	57.4	66.7	69.4	69.1	73.6	68.3	62.5	68.4	61.8	66.0	5.3
26	61.9	59.8	68.6	70.0	71.2	75.7	69.5	64.3	70.1	65.3	67.6	5.3
27	61.6	59.2	68.2	69.4	71.5	75.0	70.2	63.6	69.8	66.6	67.3	5.4
28	62.0	60.1	67.0	71.1	72.7	75.6	70.7	63.4	70.5	68.6	67.8	5.6
29	61.3	59.0	64.3	67.5	71.4	73.8	68.7	62.3	68.6	67.8	66.0	5.2
30	61.7	58.1	63.0	63.7	70.3	71.2	67.3	60.8	66.6	66.6	64.5	4.7
31	60.1	55.5	61.8	61.3	68.1	68.2	64.9	58.3	64.2	64.8	62.3	4.5
32	58.2	53.5	57.5	59.1	65.2	65.7	62.7	55.5	61.6	62.6	59.7	4.5
33	57.6	51.3	55.2	55.4	64.9	64.6	61.7	54.1	60.6	61.8	58.1	5.1
34	55.4	49.2	52.9	52.9	62.8	62.2	59.7	51.6	58.3	59.6	55.8	5.1
35	53.3	46.8	50.9	50.6	59.8	59.3	57.0	49.8	55.6	56.8	53.4	4.8
36	51.3	44.8	48.8	48.4	56.4	56.4	54.1	47.0	52.7	53.7	50.9	4.4
37	50.0	43.5	48.4	47.1	53.6	53.0	51.6	44.9	50.2	50.7	49.0	3.7
38	48.2	41.8	46.5	45.2	50.5	49.5	48.4	42.9	47.5	47.4	46.6	3.1
39	45.5	39.2	42.6	42.8	47.0	45.2	44.0	40.1	44.0	42.9	43.3	2.7
40	40.6	34.7	38.1	38.3	41.9	39.4	38.8	35.1	38.9	36.4	38.4	2.5
AL	69.8	66.3	72.8	74.9	78.4	80.5	76.0	69.5	75.7	75.7	73.5	4.8
OASPL	76.9	76.6	79.0	81.0	81.9	83.9	79.7	76.7	80.2	-	79.5	2.7
PNL	81.8	77.4	83.9	85.7	88.8	90.6	86.6	80.4	86.2	-	84.4	4.4
PNLT	82.9	78.6	84.6	86.6	89.5	91.3	87.7	81.5	87.1	-	85.3	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.6-5H.2

HUGHES 500D HELICOPTER

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 5H (HARD) - 150 M. NORTH JUNE 22,1983

FLIGHT 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	53.9	46.9	49.2	53.7	48.7	53.7	51.7	53.1	52.0	7.3	51.4	2.7
15	54.4	51.5	53.0	53.4	52.5	54.0	54.3	54.0	53.5	14.1	53.4	1.0
16	71.2	70.5	71.0	69.2	70.2	70.8	72.4	70.9	70.9	36.3	70.8	0.9
17	56.1	55.1	56.2	54.5	55.4	56.2	57.1	55.7	55.9	25.7	55.8	0.8
18	53.6	55.4	54.5	53.6	53.1	53.3	52.6	54.5	53.9	27.7	53.8	0.9
19	63.7	64.4	65.7	63.7	63.1	62.2	61.3	63.9	63.7	41.2	63.5	1.3
20	61.8	63.5	63.6	65.8	64.8	65.6	63.9	61.8	64.1	45.0	63.8	1.5
21	67.0	68.1	70.1	71.4	70.2	71.6	69.9	66.5	69.7	53.6	69.3	1.9
22	64.6	64.2	65.7	65.5	64.4	66.8	65.3	64.9	65.2	51.8	65.2	0.8
23	55.8	58.4	63.6	60.9	58.3	63.2	61.7	60.4	60.9	50.0	60.3	2.7
24	55.7	58.2	61.5	63.0	59.2	63.2	62.2	58.6	60.9	52.3	60.2	2.7
25	61.4	64.8	66.6	69.7	63.5	69.1	67.2	65.8	66.7	60.1	66.0	2.8
26	60.5	64.0	65.6	69.7	64.9	68.5	65.3	66.1	66.3	61.5	65.6	2.8
27	59.7	64.5	65.5	69.8	66.1	67.9	66.2	66.5	66.5	63.3	65.8	2.9
28	58.8	64.0	65.6	69.5	66.6	65.9	65.9	64.2	65.9	64.0	65.1	3.0
29	55.5	62.3	63.2	66.5	65.8	59.3	63.0	62.5	63.3	62.5	62.3	3.5
30	52.8	61.0	61.4	64.0	63.7	57.4	62.0	61.3	61.4	61.4	60.4	3.7
31	50.0	59.8	59.2	61.0	60.8	54.5	58.6	58.3	58.8	59.4	57.8	3.7
32	48.6	59.1	55.0	59.0	60.2	51.6	55.2	55.0	56.8	57.8	55.5	4.0
33	46.7	55.3	52.8	58.0	59.5	49.2	53.3	51.4	55.0	56.2	53.3	4.3
34	43.5	54.0	49.0	55.3	56.5	46.1	50.4	48.9	52.3	53.6	50.5	4.5
35	41.5	51.6	45.9	52.8	54.0	43.1	47.9	46.9	49.8	51.0	48.0	4.5
36	39.2	47.9	42.1	49.5	50.5	41.8	45.1	43.8	46.5	47.5	45.0	4.0
37	37.0	46.2	40.8	46.0	46.0	38.5	44.5	41.3	43.7	44.2	42.5	3.6
38	35.9	46.9	36.9	42.9	42.2	35.3	41.6	40.1	41.8	41.7	40.2	4.0
39	34.3	47.3	33.0	39.6	38.3	32.1	38.2	38.9	40.5	39.4	37.7	4.8
40	32.7	38.8	30.5	34.9	33.5	-	34.5	34.0	34.8	32.3	34.1	2.5
AL	64.5	70.4	70.8	74.3	72.4	71.0	71.0	70.4	71.2	71.2	70.6	2.8
OASPL	75.0	76.4	77.6	79.2	77.4	78.4	77.8	76.6	77.5	-	77.3	1.3
PNL	75.9	81.5	81.1	84.7	83.0	81.7	81.5	80.9	82.0	-	81.3	2.5
PNLT	76.9	82.3	82.2	85.6	83.9	82.6	82.4	81.9	82.8	-	82.2	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.6-5H.3

HUGHES 500D HELICOPTER

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/24/84

SITE: 5H (HARD) - 150 M. NORTH JUNE 22,1983

GROUND IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	56.9	46.5	45.7	53.2	49.5	52.6	51.9	58.3	53.7	9.0	51.8	4.5
15	54.2	43.2	40.7	51.8	44.2	48.9	44.5	55.4	50.6	11.2	47.9	5.5
16	52.5	46.1	45.9	51.0	45.2	47.7	43.7	53.4	49.5	14.9	48.2	3.6
17	51.2	49.1	47.9	49.8	50.1	51.3	50.5	51.9	50.4	20.2	50.2	1.3
18	49.2	45.8	48.1	50.6	48.2	48.4	47.2	49.2	48.5	22.3	48.3	1.4
19	53.4	53.8	53.3	56.4	54.5	54.5	54.0	52.8	54.2	31.7	54.1	1.1
20	61.2	62.3	60.1	63.5	64.1	63.8	62.9	60.4	62.5	43.4	62.3	1.6
21	63.6	64.1	63.4	66.4	66.8	66.6	65.6	61.4	65.1	49.0	64.7	1.9
22	51.9	54.6	54.3	57.3	55.4	57.2	57.7	51.9	55.5	42.1	55.0	2.3
23	49.6	53.5	53.9	55.3	52.5	55.3	55.1	50.9	53.7	42.8	53.3	2.1
24	51.8	55.1	54.8	55.9	54.1	56.3	56.3	53.2	54.9	46.3	54.7	1.6
25	58.4	60.4	60.2	64.1	57.5	63.8	62.3	57.9	61.3	54.7	60.6	2.6
26	55.7	58.0	57.8	62.2	55.4	61.8	57.9	54.5	58.8	54.0	57.9	2.8
27	52.1	55.9	54.9	60.6	54.0	59.2	56.8	52.2	56.7	53.5	55.7	3.1
28	48.3	53.9	54.4	58.6	53.6	56.4	54.7	50.3	54.7	52.8	53.8	3.2
29	44.9	51.2	48.4	51.8	50.9	54.6	49.8	52.3	51.2	50.4	50.5	2.9
30	43.2	48.3	46.2	50.4	47.9	51.2	47.7	43.5	48.1	48.1	47.3	2.9
31	45.3	50.4	46.2	53.1	48.4	49.5	46.5	41.8	48.8	49.4	47.6	3.5
32	42.8	47.8	40.3	45.8	47.9	46.6	43.5	41.1	45.3	46.3	44.5	3.0
33	39.1	42.2	37.6	42.5	44.6	43.3	40.5	34.1	41.5	42.7	40.5	3.4
34	39.0	42.0	36.8	39.2	42.7	40.3	38.4	32.2	39.7	41.0	38.8	3.3
35	38.6	40.3	34.3	37.3	41.8	38.5	37.9	31.6	38.4	39.6	37.5	3.2
36	37.3	37.1	34.1	33.7	39.9	35.4	34.6	31.7	36.2	37.2	35.5	2.6
37	35.8	35.3	29.7	30.5	38.3	33.7	31.7	29.1	34.1	34.6	33.0	3.3
38	37.0	35.7	-	29.7	36.6	30.4	30.7	28.6	33.9	33.8	32.7	3.6
39	48.2	46.6	-	43.1	45.0	32.6	38.6	37.9	44.1	43.0	41.7	5.6
40	44.9	42.0	-	34.4	41.9	32.2	36.3	34.7	40.2	37.7	38.1	4.8
AL	58.6	61.6	60.4	64.7	60.7	64.1	61.7	58.4	61.8	61.8	61.3	2.3
OASPL	68.4	69.2	68.4	71.9	70.2	71.7	70.4	67.8	70.0	-	69.7	1.5
PNL	71.5	73.7	71.9	75.7	73.6	75.3	73.7	69.7	73.7	-	73.1	2.0
PNLT	72.7	74.9	73.7	77.5	74.8	76.3	74.6	71.5	74.9	-	74.5	1.9

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

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 D.1.1

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

HUGHES 500D

6-22-83

SITE 2 (SOFT SITE)

HIGE		FLT.IDLE		GND.IDLE	
M-0	68.90	N-0A	56.90	N-0B	62.10
M-315	66.30	N-315A	64.20	N-315B	57.40
M-270	66.60	N-270A	65.80	N-270B	58.40
M-225	76.70	N-225A	67.90	N-225B	61.30
M-180	77.10	N-180A	66.20	N-180B	59.60
M-135	70.20	N-135A	69.80	N-135B	61.40
M-90	68.20	N-90A	71.50	N-90B	59.80
M-45	67.00	N-45A	68.90	N-45B	58.10

SITE 4H (SOFT SITE)

HIGE		FLT.IDLE		GND.IDLE	
M-0	56.40	N-0A	47.00	N-0B	53.40
M-315	58.10	N-315A	56.90	N-315B	50.40
M-270	60.80	N-270A	58.80	N-270B	50.60
M-225	69.70	N-225A	58.90	N-225B	54.50
M-180	66.10	N-180A	59.90	N-180B	51.70
M-135	62.90	N-135A	64.30	N-135B	54.00
M-90	58.40	N-90A	62.20	N-90B	53.60
M-45	59.80	N-45A	63.10	N-45B	52.50

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.1.1

COCKPIT PHOTO DATA

HELICOPTER HUGHES 500D TEST DATE 6-22-83

EVENT NO.	EVENT TYPE	TIME OF PHOTO	HEADING (DEGREES)	ALTIMETER (AGL) FT. (METERS)	IAS (KTS)	ROTOR SPEED (RPM OR %)	TORQUE (PSI)
A38	LFO 500' .9Vh	14:18:50	190	470	120	490	-
A39	LFO 500' .9Vh	14:21:41	190	490	100	490	66
A40	LFO 500' .9Vh	14:24:05	185	490	109	490	65
A41	LFO 500' .9Vh	14:28:00	190	495	108	490	62
A42	LFO 500' .9Vh	14:31:00	185	500	104	490	64
A43	LFO 500' .9Vh	14:35:45	190	500	106	490	64
A44	LFO 500' .9Vh	14:38:05	010	490	110	490	62
B45	LFO 500' .8Vh	14:40:35	010	530	105	490	63
B46	LFO 500' .8Vh	14:42:25	010	520	99	490	58
B47	LFO 500' .8Vh	14:44:32	190	480	100	490	58
B48	LFO 500' .8Vh	14:46:22	010	520	94	490	58
B49	LFO 500' .8Vh	14:48:30	190	520	96	490	58
C50	LFO 500' .7Vh	14:50:16	015	500	84	490	53
C51	LFO 500' .7Vh	14:52:25	190	520	88	490	53
C52	LFO 500' .7Vh	14:55:43	015	430	87	490	52
C53	LFO 500' .7Vh	14:56:35	195	500	96	490	52
D54	LFO 500' .6Vh	14:59:00	010	595	79	490	51
D55	LFO 500' .6Vh	15:01:08	195	560	76	490	46
D56	LFO 500' .6Vh	15:03:17	015	610	77	490	48
D57	LFO 500' .6Vh	15:06:32	195	620	80	490	47
E58	LFO 1000' .9Vh	15:13:51	200	960	109	490	63
E59	LFO 1000' .9Vh	15:14:45	015	990	108	490	63
E60	LFO 1000' .9Vh	15:16	195	1000	110	490	64

NOTE: The pilot reported an altimeter reset error which may have resulted in erroneous cockpit altitude readings for test series D and E. The reader is advised to consult Appendix F.

TABLE E.1.2

COCKPIT PHOTO DATA

HELICOPTER HUGHES 500D (CONT) TEST DATE 6/22/83

EVENT NO.	EVENT TYPE	TIME OF PHOTO	HEADING (DEGREES)	ALTIMETER (AGL) FT. (METERS)	IAS (KTS)	ROTOR SPEED (RPM OR %)	TORQUE (PSI)
F1	APPROACH	11:00:45	125	570	62	500	-
F2	APPROACH	11:03:08	130	340	53	500	-
F3	APPROACH	11:06:50	135	430	65	500	-
F4	APPROACH	11:09:30	130	550	70	500	-
F5	APPROACH	11:11:23	135	420	56	500	-
F6	APPROACH	11:14:49	135	530	62	490	25
G7	APPROACH	11:16:30	135	550	72	490	22
G8	APPROACH	11:19:08	140	470	67	490	-
G9	APPROACH	11:22:09	140	595	83	500	22
G10	APPROACH	11:25:11	140	660	65	500	-
G11	APPROACH	11:28:20	145	740	71	500	30
H12	APPROACH	11:32:00	145	670	53	500	35
H13	APPROACH	11:35:52	145	595	51	500	30
H14	APPROACH	11:40:37	150	600	63	500	20
H15	APPROACH	11:47:15	145	600	46	500	30
H16	APPROACH	11:51:11	150	680	56	500	30
I17	TAKEOFF	11:57:23	340	510	55	500	80
I18	TAKEOFF	12:01:05	340	580	58	500	82
I19	TAKEOFF	12:04:13	340	510	59	490	85
I20	TAKEOFF	12:07:17	340	750	59	490	85
I21	TAKEOFF	12:11:35	340	580	61	490	85
I22	TAKEOFF	12:15:28	340	540	62	490	85
J23	APPROACH	12:51:21	165	380	68	500	12
J24	APPROACH	12:55:53	170	930	65	500	14
J25	APPROACH	12:58:53	170	810	70	500	10
J26	APPROACH	13:02:33	160	700	63	500	-

TABLE E.1.3

COCKPIT PHOTO DATA

HELICOPTER HUGHES 500D (CONT) TEST DATE 6/22/83

EVENT NO.	EVENT TYPE	TIME OF PHOTO	HEADING (DEGREES)	ALTIMETER (AGL) FT. (METERS)	IAS (KTS)	ROTOR SPEED (RPM OR %)	TORQUE (PSI)
K27	TAKEOFF	13:06:33	345	460	65	490	81
K28	TAKEOFF	13:09:32	350	580	63	490	85
K29	TAKEOFF	13:11:18	350	620	58	490	85
K30	TAKEOFF	13:14:20	350	460	62	490	84
K31	TAKEOFF	13:17:37	350	460	64	490	87
K32	TAKEOFF	13:21:18	350	920	63	490	86
L33	APPROACH	13:24:53	180	680	60	500	14
L34	APPROACH	14:00:20	185	300	62	500	16
L35	APPROACH	14:04:53	185	380	60	500	7
L36	APPROACH	14:07:37	190	380	57	500	20
L37	APPROACH	14:11:23	185	550	59	500	18

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.

HELICOPTER: HUGHES 500D

TABLE F.1

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER(0.9*VH)/TARGET IAS=125 MPH

	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
A38	453.4	446.7	408	447.2	371.8	361.5	639.2	39.7	642.9	39.4	.1	-9.8	-4.8	-4.1
A39	485.7	482.7	473.7	486.9	464.2	459.9	683	43.9	684.1	43.9	.5	-3	-1.2	-1
A40	483.9	482.7	476.6	483.3	470.8	468.9	685	44.1	685.7	44.1	.1	-1.6	-.7	-.6
A41	413	397.1	449.7	466.2	479	460.6	666.6	42.4	663.4	42.6	8	-.6	3.7	3.4
A42	476.3	471	489.1	494.2	499.4	493.3	693.8	44.8	692.6	44.9	2.7	0	1.3	1.2
A43	477.4	473.9	472.9	483.3	469.3	464.7	682.4	43.9	682.8	43.8	1.1	-2.1	-.4	-.3
A44	450.3	476.8	452.7	391.8	454.6	487.9	668.6	42.6	668.4	42.6	-9.7	11.1	.6	.2
AVERAGE	462.9	461.6	460.4	464.7	458.4	456.7	674.1	43.1	674.3	43				
STD. DEV	26.1	30.9	26.9	35.8	40.7	44	18.1	1.7	17.2	1.8				

HELICOPTER: HUGHES 500D

TABLE F.2

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER(0.8*VH)/TARGET IAS=111 MPH

	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
B45	459.6	450.6	490.1	494.2	514.5	504.5	694.5	44.9	691.7	45	5.1	1.2	3.1	2.8
B46	500.8	501.3	505.2	501.8	508.6	509.4	705.2	45.8	704.8	45.8	.1	.9	.5	.4
B47	483.5	484.2	471.6	476.3	462.2	462.6	681.6	43.8	682.6	43.7	-.8	-1.5	-1.2	-1
B48	488.7	487.2	501.4	498	511.6	510.3	702.5	45.5	701.3	45.6	1.3	1.4	1.3	1.2
B49	500.5	499.7	483.1	494.2	469.3	467.5	689.6	44.5	691.1	44.4	-.5	-3	-1.8	-1.5
AVERAGE	486.6	484.6	490.3	492.9	493.2	490.9	694.7	44.9	694.3	44.9				
STD. DEV	16.9	20.4	13.6	9.8	25.3	23.7	9.6	.8	8.8	.9				

TABLE F.3

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER(0.7*VH)/TARGET IAS=97 MPH

	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
C50	485.2	485.7	483.8	483.3	482.8	483.4	690	44.5	690.2	44.5	-.2	0	0	0
C51	500.5	499.7	499.3	501.8	498.4	497.3	701	45.4	701.1	45.4	.2	-.4	0	0
C52	473.6	471	489.1	486.9	501.5	498.8	693.8	44.8	692.4	44.9	1.9	1.4	1.6	1.4
C53	334.2	337.5	308.4	314.5	287.9	291	580.7	32.1	582.4	31.9	-2.6	-2.6	-2.6	-2.3
AVERAGE	448.4	448.5	445.2	446.6	442.6	442.6	666.4	41.7	666.5	41.7				
STD. DEV	76.9	74.9	91.4	88.4	103.5	101.3	57.3	6.4	56.3	6.5				

TABLE F.4

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 500 FT.FLYOVER(0.6*VH)/TARGET IAS=83 MPH

	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
D54	426.2	433.1	416.1	405.8	408.1	416.4	644.4	40.2	645.2	40.2	-3.1	1.2	-.9	-.8
D55	397.1	388.8	360.4	398.4	331.2	319.3	609.9	36.2	612.7	36	1.1	-9	-3.9	-3.3
D56	448.2	449.3	441.3	442.6	435.8	436.8	660.9	41.9	661.5	41.9	-.7	-.6	-.6	-.5
D57	351.9	351.9	350.8	351.5	349.8	349.7	604.2	35.5	604.3	35.5	0	-.1	0	0
AVERAGE	405.9	405.8	392.2	399.6	381.2	380.6	629.9	38.5	630.9	38.4				
STD. DEV	41.6	44.1	43.6	37.4	49	55.2	27.3	3.1	27	3.1				

HELICOPTER: HUGHES 500D

TABLE F.5

TEST DATE: 6-22-83

OPERATION: 1000 FT.FLYOVER(0.9*VH)/TARGET IAS=125 MPH

	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
E58	946.5	944.9	961.9	957.3	974.1	972.8	1080.4	62.9	1078.6	62.9	1.4	1.8	1.6	1.4
E59	997.6	1005.8	993.8	977.2	990.7	1000.9	1108.9	63.7	1109.3	63.7	-3.2	2.8	-.2	-.3
E60	971.9	986.7	970.7	938.1	969.7	988.2	1088.3	63.1	1088.4	63.1	-5.5	5.8	.1	0
AVERAGE	972	979.1	975.4	957.5	978.2	987.3	1092.5	63.2	1092.1	63.2				
STD. DEV	25.5	31.1	16.5	19.6	11.1	14.1	14.7	.4	15.7	.4				

HELICOPTER: HUGHES 500D

TABLE F.6

TEST DATE: 6-22-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=62 MPH

	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
F1	257.4	245.4	315.9	312.1	362.6	350	584.7	32.7	580.7	33.1	7.7	4.4	6.1	5.4
F2	270	263.1	315.2	306.9	351.3	344.5	584.3	32.6	581.2	32.9	5.1	4.4	4.7	4.2
F3	240.6	232.3	300.6	287.8	348.4	340.4	576.6	31.4	572.6	31.8	6.4	6.1	6.3	5.6
F4	244.9	228.7	310.1	312.1	362.1	344.5	581.6	32.2	577.1	32.6	9.6	3.8	6.7	6.1
F5	247.1	231.1	319.5	317.5	377.1	360	586.6	33	581.6	33.4	10	4.9	7.5	6.7
F6	230	221.7	289.5	276.9	336.9	328.9	570.8	30.5	567	30.9	6.4	6	6.2	5.5
AVERAGE	248.3	237.1	308.5	302.2	356.4	344.7	580.8	32.1	576.7	32.5				
STD. DEV	13.8	14.9	11.4	16.1	13.9	10.3	6	.9	5.9	.9				

HELICOPTER: HUGHES 500D

TABLE F.7

TEST DATE: 6-22-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=72 MPH

	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
G7	228.9	220.6	286.9	274.9	333.2	325.2	569.5	30.2	565.8	30.6	6.3	5.8	6.1	5.4
G8	232.1	225.2	298.6	279	351.7	345.8	575.5	31.3	571.2	31.7	6.2	7.7	7	6.2
G9	257.3	248.2	318.6	306.9	367.5	358.6	586.2	32.9	581.9	33.3	6.8	6	6.4	5.7
G10	237.6	231.1	285.3	274.9	323.2	317	568.7	30.1	565.7	30.4	5.1	4.9	5	4.4
G11	256	245.4	312.9	306.9	358.2	347.2	583.1	32.5	579.2	32.8	7.1	4.7	5.9	5.3
AVERAGE	242.4	234.1	300.5	288.5	346.8	338.8	576.6	31.4	572.8	31.8				
STD. DEV	13.4	12.2	15	16.9	18.2	17.1	7.9	1.3	7.5	1.3				

HELICOPTER: HUGHES 500D

TABLE F.8

TEST DATE: 6-22-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=52 MPH

	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
H12	257.4	248.2	307.4	301.9	347.3	337.8	580.2	32	576.8	32.3	6.2	4.2	5.2	4.6
H13	224.8	216.2	290	274.9	342	333.9	571.1	30.5	566.9	30.9	6.8	6.8	6.8	6.1
H14	244.9	232.3	304.7	301.5	352.4	339.1	578.7	31.8	574.7	32.1	8	4.4	6.2	5.6
H15	258	246.8	308.3	306.9	348.4	336.5	580.6	32.1	577.2	32.4	7	3.4	5.2	4.7
H16	220.4	208	294.2	283.3	353	340.4	573.2	30.9	568.4	31.3	8.7	6.6	7.7	6.8
AVERAGE	241.1	230.3	300.9	293.7	348.6	337.5	576.8	31.5	572.8	31.8				
STD. DEV	17.7	18	8.3	13.8	4.4	2.5	4.3	.7	4.8	.7				

HELICOPTER: HUGHES 500D

TABLE F.9

TEST DATE: 6-22-83

OPERATION: ICAO TAKEOFF

	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
I17	243.6	217.3	367	361.1	465.4	437.5	613.8	36.7	604.5	37.4	16.3	8.8	12.6	11.5
I18	245.9	218.4	373.7	368.3	475.6	446.4	617.8	37.2	608.1	37.9	16.9	9	13	11.9
I19	261.4	229.9	405.1	400.4	519.7	486.1	637.3	39.5	625.8	40.2	19.1	9.9	14.6	13.3
I20	250.9	229.9	399.1	368.3	517.3	497.1	633.5	39.1	621.8	39.8	15.7	14.7	15.2	13.8
I21	261	233.6	416	396.1	539.6	511.6	644.3	40.2	631.7	41	18.3	13.2	15.8	14.4
I22	255.2	226.3	406.5	391.8	527.1	497.1	638.2	39.6	626	40.3	18.6	12.1	15.4	14
AVERAGE	253	225.9	394.6	381	507.5	479.3	630.8	38.7	619.6	39.4				
STD. DEV	7.5	6.7	19.7	17	29.8	30.2	12.2	1.4	10.9	1.4				

HELICOPTER: HUGHES 500D

TABLE F.10

TEST DATE: 6-22-83

OPERATION: 9 DEGREE APPROACH/TARGET IAS=62 MPH

	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
J23	260.5	261.6	378.1	313.7	471.9	478.1	620.5	37.5	611.5	38.2	6	18.5	12.4	10.9
J24	229.7	216.2	313.1	299.5	379.6	366.1	583.2	32.5	577.5	33	9.6	7.7	8.7	7.7
J25	229.9	217.3	311.8	297	377	364.6	582.5	32.4	576.9	32.9	9.2	7.8	8.5	7.6
J26	234.3	215.2	331.4	323.1	408.8	388.9	593.2	34	586.3	34.5	12.4	7.6	10	9
AVERAGE	238.6	227.6	333.6	308.3	409.3	399.4	594.9	34.1	588.1	34.7				
STD. DEV	14.8	22.7	31	12.3	44.1	53.6	17.8	2.4	16.2	2.5				

TABLE F.11

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: STANDARD TAKEOFF

	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
K27	233.2	219.5	335	312.1	416.2	403.2	595.2	34.2	588	34.8	10.7	10.5	10.6	9.5
K28	259.1	249.6	373.8	334.8	465.3	458.1	617.9	37.2	609.1	37.9	9.8	14.1	12	10.7
K29	250.9	215.2	415.5	409.3	546.8	508.7	644	40.2	630.6	41	21.5	11.4	16.6	15.3
K30	260.7	232.3	402.7	391.8	515.9	486.1	635.8	39.3	624.4	40	18	10.9	14.5	13.2
K31	253.6	198.5	405	449.2	525.7	462.9	637.2	39.5	625.1	40.2	27	1.6	15	14.1
K32	242.9	206	400.3	400.4	525.9	486.1	634.3	39.1	621.8	39.9	21.6	9.9	15.9	14.6
AVERAGE	250.1	220.2	388.7	382.9	499.3	467.5	627.4	38.3	616.5	39				
STD. DEV	10.4	18.5	29.7	50.6	49	36.4	18	2.2	15.7	2.3				

TABLE F.12

HELICOPTER: HUGHES 500D

TEST DATE: 6-22-83

OPERATION: 12 DEGREE APPROACH/TARGET IAS=62 MPH

	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
L33	211.1	190.7	327.5	312.1	420.3	399.5	591	33.6	582.9	34.3	13.9	10.1	12	10.8
L34	226.4	206	333.5	323.1	418.9	397.7	594.4	34.1	586.8	34.8	13.4	8.6	11	9.9
L35	214.8	200.4	320.2	297	404.3	390.6	587	33.1	579.8	33.7	11.1	10.8	10.9	9.8
L36	214.8	194.1	311.2	306.9	388	366.1	582.1	32.3	575.6	32.9	12.9	6.9	9.9	9
L37	218.9	202.2	325.6	306.9	410.6	394.1	590	33.5	582.5	34.1	12	10.1	11	9.9
AVERAGE	217.2	198.7	323.6	309.2	408.4	389.6	588.9	33.3	581.5	34				
STD. DEV	5.9	6.2	8.4	9.5	13.1	13.6	4.6	.7	4.1	.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	measured in the direction from which the wind is blowing
Wind Speed	expressed in knots

Table G.1

DATE: 6 / 22 / 83

TIME: 758 EST FLIGHT # 1 TIME: 858 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1013.7	20.4	86	30	4
100	1010.2	19.8	83	-999	-999
200	1006.6	19.2	86	-999	-999
300	1003.0	18.8	89	51	7
400	999.5	18.4	91	62	9
500	996.0	18.0	93	44	8
600	992.4	17.8	95	20	7
700	988.9	17.7	96	15	7
800	985.4	17.3	96	24	6
900	981.9	17.0	96	32	6
1000	978.4	16.8	97	33	6
1100	974.9	16.6	97	38	7
1200	971.4	16.4	97	45	6
1300	968.0	16.2	97	60	7
1400	964.5	16.0	97	65	10
1500	961.1	15.9	97	57	12
1600	957.7	15.7	97	55	13
1700	954.2	15.6	97	56	13
1800	950.8	15.5	97	55	14
1900	947.4	15.5	96	55	14
2000	944.0	15.5	95	56	14
2100	940.7	15.5	93	61	12
2200	937.3	15.5	88	63	11
2300	933.9	15.5	83	60	11
2400	930.6	15.5	82	70	9
2500	927.3	15.5	86	82	8
2600	924.0	15.4	88	81	9
2700	920.7	15.3	87	83	10
2800	917.4	15.2	87	83	11
2900	914.1	15.0	87	79	12
3000	910.8	14.9	86	77	11

Table G.2

DATE: 6 / 22 / 83

TIME: 848 EST FLIGHT # 2 TIME: 948 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1014.0	21.4	81	30	5
100	1010.5	21.0	82	-999	-999
200	1006.9	20.7	83	-999	-999
300	1003.4	20.3	84	8	4
400	999.9	20.0	85	52	5
500	996.3	19.6	87	45	5
600	992.8	19.3	89	45	5
700	989.3	18.9	91	53	6
800	985.8	18.6	92	58	6
900	982.4	18.3	93	59	5
1000	978.9	18.0	94	56	4
1100	975.4	17.7	94	53	5
1200	972.0	17.4	95	53	5
1300	968.5	17.1	96	51	6
1400	965.1	16.9	96	47	6
1500	961.7	16.8	97	39	6
1600	958.3	16.6	97	35	6
1700	954.8	16.4	97	34	7
1800	951.4	16.3	98	45	7
1900	948.0	16.1	98	59	6
2000	944.6	15.7	98	73	6
2100	941.2	15.3	97	62	6
2200	937.8	14.8	97	48	5
2300	934.4	14.5	96	50	5
2400	931.1	14.6	90	52	8
2500	927.8	14.7	84	61	9
2600	924.5	15.0	85	66	9
2700	921.2	15.2	85	68	9
2800	917.8	15.5	86	68	10
2900	914.6	15.3	86	71	11
3000	911.3	15.0	86	76	11

APPENDIX H

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 H.1.1

SURFACE METEOROLOGICAL DATA

TEST DATE: June 22, 1983 HELICOPTER: Hughes 500D LOCATION: DULLES, SITE #4*

TIME (EDT)	TEMPERATURE °F(°C)	HUMIDITY (%)	WINDSPEED AVG (MPH)	WINDSPEED RANGE (MPH)	WIND DIRECTION (DEGREES)	REMARKS
05:45	65(18)	100	1			
06:00	65(18)	100	3			
06:15	64(18)	99	2			
06:30	65(18)	98	8			
06:45	66(19)	90	1			
07:00	66(19)	90	1			
10:45	77(25)	72	2			
11:00	76(24)	68	6			
11:15	82(28)	65	1			
11:30	80(27)	65	2			
11:45	85(29)	65	2			
12:00	84(29)	60	2			
12:15	80(27)	58	2			
12:30	86(30)	56	1			
12:45	90(32)	54	4			
1:00	92(33)	50	7			
1:15	88(31)	52	6			
1:30	92(33)	48	1			
1:45	95(35)	47	3			
2:00						
2:15	92(33)	46	3			
2:30	88(31)	46	3			
2:45	85(29)	46	3			

SENSOR HEIGHT IS 5 FEET ABOVE GROUND

TABLE H.1.2

SURFACE METEOROLOGICAL DATA

TEST DATE: June 22, 1983 HELICOPTER: Hughes 500D (CONT) LOCATION: DULLES, SITE #4*

TIME (EDT)	TEMPERATURE °F(°C)	HUMIDITY (%)	WINDSPEED AVG (MPH)	WINDSPEED RANGE (MPH)	WIND DIRECTION (DEGREES)	REMARKS
3:00	86(30)	44	2			
3:15	86(30)	44	5			

SENSOR HEIGHT IS 5 FEET ABOVE GROUND