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HELICOPTER NOISE SURVEY FOR SELECTED CITIES IN THE CONTIGUOUS UNITED STATES

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16. Abstract

THE FAA HAS CONDUCTED A SERIES OF NOISE SURVEYS IN THE FOLLOWING URBAN AREAS: CHICAGO, IL; LONG BEACH, CA; NEW ORLEANS, LA; PORTLAND, OR: AND SEATTLE, WA. IN EACH METROPOLITAN AREA, NOISE MEASUREMENTS WERE MADE AT THREE OR FOUR HELIPORTS OR HELIPADS. LAND USE SURROUNDING THE HELIPORTS RANGED FROM RESIDENTIAL TO INDUSTRIAL. NOISE LEVELS FOR L_{max} WERE RECORDED DURING EACH TEST AT EACH HELIPORT. ALSO RECORDED WERE AMBIENT NOISE LEVELS WHICH WERE USED AS A BASIS FOR COMPARISON OF NOISE ASSOCIATED WITH HELICOPTER OPERATIONS VERSUS URBAN BACKGROUND NOISE LEVELS.

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CHAPTER 1

INTRODUCTION

Civilian helicopter traffic is growing rapidly and the resulting noise is becoming increasingly noticeable, especially in major urban areas. The frequency of complaints about helicopter noise has remained relatively low, probably because of the efforts of helicopter operators, heliport operators, urban planning officials and the FAA to keep community noise impacts at a minimum through such measures as routing helicopters away from noise-sensitive land uses and operating helicopters so as to minimize the levels of noise emitted and transmitted to the ground.

The FAA has instituted a series of surveys to enable it to keep abreast of the noise performance of the various helicopter models and to assemble a body of data for use in estimating the community noise contributions of actual and projected helicopter operations and facilities. Extensive surveys have been performed in New York City and in Pheonix, Arizona, and smaller surveys have been performed in several other places.

This report describes surveys of non-military helicopter noise at and near helipads in five metropolitan areas: Chicago, IL; Long Beach, CA; New Orleans, LA; Portland, OR; and Seattle, WA. In each metropolitan area, noise measurements were made at three or four heliports or helipads. At each heliport or helipad, three noise monitoring stations were set up in a linear array at distances of approximately 150 feet, 300 feet and 450 feet from the helipad along a suitable approach or departure flight path. (Where possible, a commonly used flight path was selected. In some cases, it was not feasible to set up stations along a commonly used path.) The stations were used to measure and record noise levels during the performance of a standard series of standardized helicopter maneuvers or operations consisting of approach and departure over the array of monitoring stations, idling on the ground, and hovering close to the ground ("hover in-ground effect"). All noise measurements were made using Type 1 meters using slow response and "A" frequency weighting.

In addition to measuring noise levels during each standard maneuver, one monitoring station, the most distant from the helipad, was used to measure the effects of an entire series of maneuvers on community noise at each site. For this purpose noise levels were measured throughout a period of 30 or 60 minutes which included the helicopter tests, and for a similar period when tests were not being performed.

The siting of the third station was constrained by similar circumstances in each of the five cities surveyed: the busiest non-military helipads tend to be located in airports. Generally, Station 3 was located approximately 450 feet from the helipad. At several sites this placed it close to runways or taxiways used by fixed-wing aircraft and neighboring helipads. As a result, observed noise levels at Station 3 were sometimes lower during the tests than before or after the tests, and even when the noise level was higher during the test it cannot always be stated with confidence that this was entirely due to the testing.

In the five cities surveyed for this report the helipads having the highest daily numbers of helicopter operations are located at airports. With the exception of Long Beach Airport which is located adjacent to several residential communities, land surrounding the airports is predominantly industrial or commercial. For this reason the noise levels from the helicopter test maneuvers at the busiest helipads are generally not detectable in residential areas the nearest of which may be located several thousand feet away. In cases where helipads are located at airports the effect of helicopter noise on the residential areas around airports comes primarily from helicopter overflights into, not from helipad operations.

Each metropolitan area surveyed is the subject of a separate chapter of this report. In addition to the noise measurement data obtained, each chapter provides data on location, frequency of helicopter operations, and type of helicopter operations at every identifiable helipad or heliport in regular civilian use in the metropolitan area. Information is also provided on any helicopter noise abatement procedures in effect and any available noise complaint statistics. For each helipad or heliport where noise measurements were made, the land use in the vicinity is described.

In all, noise measurements were obtained at 18 helipads for eight helicopter models. The measurements are summarized in Table 1 which reports the highest value of Lmax (Maximum Noise Level) recorded at Station 1, for each test site.

Values of Lmax at Station 1 ranged from 89.1 to 103.4 dB(A). This wide range is attributable to several factors: the use of different helicopter models in the tests; differences in the distance from Station 1 to the helipad; differences between the elevation of Station 1 and the helipad; differences in the helicopter angle of approach or take-off; deviation of approach or departure path from the direction of the line of measurement stations; and differences in ground surface and structures affecting sound propagation. Two other reasons for variation are indicated in the table: the maneuver being performed when the largest Lmax value was recorded, and the distance from the helipad to Station 1. (This distance is greater than the distance from the helicopter to Station 1 when the longest Lmax occurs during an approach or take-off.)

Table 1

SUMMARY OF MAXIMUM NOISE LEVELS RECORDED IN TESTS

City	Helipad	Helicopter Model	Type of Maneuver	Station 1 to Helipad (feet)	Lmax At Station 1
Long Beach, CA	LA Sheriff's Aero Bureau	Hughes 300B	takeoff	174	96.0
	Air Logistics	Bell 206-L	approach	188	95.2
	Pacific Wing and Rotor	Robinson 22	takeoff	254	92.3
Seattle, WA	Aerocopter, Inc.	Bell 206B	hover	100	101.2
	Rooftop A	Hughes 500D	takeoff	110	100.4
	Weyerhauser	Bell 206B	approach	150	100.9
	Rooftop B	Bell 206B	takeoff	119	94.0
Portland, OR	Emanuel Hospital	Messer-schmitt B105	hover	227	90.3
	Portland Public Use Heliport	Bell 206B	approach	112	95.0
	Floating Point Systems	Agusta A109A	approach*	150	103.4
	KATU-TV	Hughes 500D	takeoff*	150	89.4
Chicago, IL	Executive Helicopter	Bell 206B	takeoff*	145	94.7
	WGN-TV	Enstrom F28	approach*	150	89.1
	Meigs Field	Hughes 500D	hover	155	93.4
	U. of Chicago Hospital	Aerospatiale Twin Star	approach	108	101.4
New Orleans, LA	Pumpkin Heli-copters, Inc.	Bell 206L	takeoff*	300	94.5
	Chevron Oil	Bell 206B	hover +	150	90.0
	Petroleum Helicopters, Inc.	Bell 206B	takeoff	140	96.4

* = Maneuver was not performed directly over measurement array.
+ = No takeoff or approach was performed at this test site.

Table 2 shows the Leq (Equivalent Noise Level) and Lmax observed at Station 3 at each helipad during the period of either 30 or 60 minutes in which the helicopter tests were performed and during one or more periods of equal duration in which there were no helicopter tests. The Lmax for the helicopter tests ranged from 68 dB(A) to 112 dB(A); and for ambient conditions (i.e. no helicopter testings) Lmax ranged from 74 dB(A) to 114 dB(A).

The sources of noise giving rise to Lmax under ambient conditions are noted in the table. Lmax levels of over 100 dB(A) were due to jet aircraft taking off and occurred only where Station 3 had to be located in an airport. In several instances the Lmax value recorded during the helicopter tests was lower than the Lmax value recorded in the absence of tests. Generally, the data suggest that at horizontal distances of 440 feet or more, the ambient noise included intrusive noise from other sources that had higher levels than the noise due to the helicopter tests. However, with the exception of one instance, the observed Equivalent Noise Level, Leq, indicates that the testing raised the general level of noise at Station 3, and Leq for the testing period ranged from 1 dB(A) up to 24 dB(A) higher than during ambient conditions. Some of this difference is undoubtedly due to differences in the non-helicopter noise levels between the testing and non-testing periods, but in most cases it appears to be a result of the testing.

The report also contains noise measurements obtained for helicopters operating in normal service (i.e. not performing noise test maneuvers) at each of the cities surveyed. The normal service operations included take-offs, landings, hovers, idles, and overflights at various cruise altitudes. Some of these data were obtained at the noise measurement stations set up for the tests, and some at locations in residential areas. For comparison purposes, ambient noise measurements were made during numerous short intervals (e.g. 5 minutes) at the residential locations while waiting for helicopter noise events to occur.

Table 2

EQUIVALENT AND MAXIMUM NOISE LEVELS AT STATION 3
WITH AND WITHOUT HELICOPTER TESTING

City/ Helipad	Station 3 Land Use	Distance To Helipad (feet)	Sample Period (min)	Community noise at Station 3: With Helicopter Testing Leq (dB(A))	Lmax (dB(A))	Without Helicopter Testing Leq (dB(A))	Lmax (dB(A))	Source of Non-test Lmax
Long Beach, CA:								
LA Sheriff's Aero Bureau	open space	685	30	65	82	61/65	85	helicopter flyover
Air Logistics	airport	626	60	63	--	62	--	--
Seattle, WA:								
Aerocopter, Inc.	airport	480	60	84	--	77/73	114	Lear Jet warm-up
Rooftop A	CBD	665	60	69	85	68	87	truck brakes
Weyerhauser	airport	452	30	71	91	73	92	commercial Jet takeoff
Portland, OR:								
Emanuel Hospital	residential	516	60	85	68	58/62	80	heavy truck
Portland Public Use Heliport	open space	435	60	66	85	60	74	Bell 206B landing
Floating Point Systems	commercial/ residential	474	60	74	97	52/61	81	helicopter flyover
KATU-TV	CBD	500	60	68	88	63/64	94	heavy truck
Chicago, IL:								
Executive Helicopter	airport	445	60	80	105	68/79	101	Commercial Jet takeoff

Table 2 (continued)

City/ Helipad	Station 3 Land Use	Distance To Helipad (feet)	Sample Period (min.)	Community noise at Station 3: With Helicopter Testing Leq (dB(A))	Lmax	Without Helicopter Testing Leq (dB(A))	Lmax	Source of Non-test Lmax
W.G.N-T.V.	open space	450	60	64	88	57/63	89	helicopter approach
Meigs Field	airport	455	60	76	102	73/74	98	GA plane taxiing
University of Chicago Hospital	open space	588	60	67	85	57/61	87	ambulance
New Orleans, LA:								
Pumpkin Helicopters	airport	621	60	85	112	70/61	89	helicopter takeoff
Chevron Oil	airport	450	60	68	86	70	97	helicopter at 30 feet
Petroleum Helicopters	open space	440	60	67	84	66/68	91	helicopter approach

-- = No data obtained due to equipment malfunction.

1.1 ORGANIZATION OF REPORT

The remainder of this report is organized as follows. Chapter 2 describes the methodology used in the noise measurement surveys. Chapter 3 describes the noise monitoring equipment used. Chapters 4 through 8 present the noise measurement data obtained from the standard sets of helicopter maneuvers and from in-service (not test) helicopter operations at each of five cities surveyed. Each of these chapters is divided into sections with the following headings: Overview of Helicopter Operations, Land Use and Helicopter Noise Abatement Procedures; Standardized Maneuver Tests, and Actual In-Service Helicopter Operations. In addition, Chapter 7 (Chicago, IL) also contains a section which presents the noise data measured for actual in-service operations at a public use heliport.

Chapter 2

METHODOLOGY USED IN NOISE MEASUREMENT SURVEYS

The approach taken to characterize community noise impacts of helicopter noise depends on identifying several distinct maneuvers that comprise a typical helicopter operation. These maneuvers are: warm-up of the engine, idle, hover before takeoff, takeoff, level flight, landing, and cool down of the engine. The noise level produced during each of these maneuvers differs considerably. For this reason separate noise measurements are made for each maneuver whenever possible. Two quite different testing procedures were used to obtain these noise measurements: Standardized Maneuver Tests, and measurement of each maneuver during Actual In-Service Operations.

2.1 STANDARDIZED MANEUVER TESTS

2.1.1 Test Measurement Procedure

In the standardized maneuver test procedure, a helicopter performs a prescribed series of maneuvers (idle, hover, takeoff and approach). Three noise monitoring stations are positioned in a straight line array extending approximately 450 feet from the helipad. Because of physical barriers, such as roads or buildings, distances between stations differ somewhat between test sites. In general, the distances between stations range from 150 to 200 feet. A typical test series takes approximately 30 minutes to complete. The amount of time varies depending on the number and duration of the maneuvers performed. In each series, the pilot is requested to perform takeoffs and approaches directly over the noise measurement array, if possible. In some tests this is not possible due to noise abatement rules, wind conditions or physical obstacles present at the test site. In tests where the takeoff or approach is not directly over the noise measurement array, as much information as possible has been provided on distance and altitude of the helicopter in respect to the noise measurement array to assist analysts in interpreting the measurements.

The sound levels generated in each maneuver are measured and recorded on a report form at each station. The two stations closest to the helipad, Stations 1 and 2, measure Sound Exposure Levels (SEL), Equivalent Sound Pressure Levels (Leq), and Maximum Sound Pressure Levels (Lmax) using Integrating Sound Level Meters (ISLM). Station 3 measures Lmax levels with a Community Noise Analyzer (CNA). The start and stop times for each test maneuver measurement period are synchronized between stations to ensure the comparability of the data. Noise levels at all three stations are measured with A-frequency weighting and slow response-time averaging. Noise levels measured are not adjusted for temperature, humidity or wind conditions. However, relative humidity or dew point and wind speed and direction are obtained and presented with the noise measurement data. Graphic Level Recorders (GLR) record the Sound Pressure Level measured by each ISLM and the CNA as a time-chart on graph paper.

Distances between the monitoring stations and the helipad are measured using a 100-foot tape. A photographic scaling technique is used to estimate the altitude of the test helicopter at a point along the noise measurement array during departure and approach maneuvers. (Society of Automotive Engineers, Aerospace Information Report 902, 485 Lexington Ave., New York, N.Y. 10017). Due to the limited amount of control that is available over the test conditions, however, the photo scaling estimates should be considered very approximate. In a few instances, because of camera malfunctions or hinderances, no photographs are available for photo scaling. In these instances the altitude of the helicopter is estimated visually. In each case where the estimated altitude is reported a notation is provided indicating which method is used.

2.1.2 Measurement of Contribution to Ambient Noise

To evaluate the contribution of noise levels from the helicopter test maneuvers to ambient noise levels, two types of ambient noise samples are taken. One type includes the noise levels produced by the helicopter test maneuvers, while the other type does not. Ambient noise sample periods are at least 30 minutes. During each sample period a log is kept at each noise monitoring station of the maximum sound pressure level (Lmax) of any intrusive noise events that occur. Noise level data that are recorded for each ambient noise sample period include Leq, Lmax, Minimum Sound Pressure Level (Lmin), and exceedance levels for n = .1, 1, 10, 50, 90, and 99 percentiles (i.e., noise levels that are exceeded "n" percent of the sample period).

2.1.3 Calibration of Instruments

All noise measurement instruments are calibrated before and after each test. The instruments are quite stable and almost always preserve their calibration throughout a test.

2.1.4 Test Data Reported

The noise level data for the standardized test maneuvers at each test site are presented in three principal types of tables. Graphic level recorder charts for each station are also presented displaying sound pressure levels recorded during each helicopter test maneuver. The first type of table is labeled

"Noise Data For Standardized Helicopter Maneuvers," and presents the Leq, SEL, and Lmax single-event noise level for each of the standardized maneuvers at Stations 1 and 2, and the Lmax for Station 3. Because a community noise analyzer (CNA) was used at Station 3 to measure ambient noise for 30 to 60 minute periods, it was not possible to record Leq or SEL values for single events at that station.

The second type of table, labeled "Ambient Noise Levels," presents Lmax, Lmin, Leq and distributional exceedance levels for ambient noise recorded by the CNA during a period of at least one-half hour that included the helicopter test maneuvers. This table also contains brief remarks identifying non-helicopter intrusive noise events that occurred during the measurement periods.

The third type of table, labeled "Selected Comparisons of Maximum Sound Levels," presents Lmax values at Station 3 for various non-helicopter noise events that occurred during the noise measurement periods when the CNA was operating, along with the Lmax for each helicopter test maneuver.

2.2 ACTUAL IN-SERVICE OPERATIONS TESTS

The standardized maneuver tests do not include overflights at cruise altitude. As well as this deficiency, there is always concern that the noise emitted in the test maneuvers may not be representative of noise from normal helicopter operations because the tests focus the operator's attention on noise and lead them, consciously or unconsciously, to operate especially quietly. Recording noise levels of helicopters during normal operations provides data on overflights as well as a check on the validity of the standard maneuver noise tests.

To measure noise levels for helicopters in normal operations, noise monitoring stations are set up at various locations, usually at a helipad or along commonly used helicopter flight corridors, and noise levels from particular helicopter events (i.e., landings, takeoffs, overflights, etc.) are recorded at each station.

In addition to recording the noise levels for each event, the operator of each station also notes the direction of the helicopter's flight, estimates its altitude, notes the type of helicopter and any other sources of intrusive noise (e.g., a passing truck), that occur during the measurement period.

Table 2.1 shows typical noise levels of various noise sources commonly found in an urban environment. These data are provided so that the helicopter noise levels measured in the tests can be easily compared with noise levels of typical non-helicopter noise sources.

TABLE 2.1

TYPICAL A-WEIGHTED SOUND LEVELS

Event (at given distance) or Environment	dB(A)
50 HP Siren (100')	132
Jet Takeoff (200')	122
Riviting Machine	110
Casting Shakeout Area	110
Cut-off Saw	104
Electric Furnice Area	100
Textile Weaving Plant	92
Subway Train (20')	90
Boiler Room and Printing Press Plant	90
Pneumatic Drill (50')	82
Inside Sports Car (50 mph)	80
Freight Train (100'), Vacuum Cleaner (10'), Speech (1')	70
Near Freeway (Auto Traffic), Large Store, Accounting Office	60
Large Transformer (200')	52
Private Business Office, Light Traffic (100'), Average Residence	50
Minimum Levels - Chicago Residential Area at Night	40
Soft Whisper (5')	32
Studio (Speech)	30
Studio for Sound Pictures	20
Threshold of Hearing (Youths, 1kHz-4kHz)	0

Source: Arnold P.G. Peterson, Gross, Ervin E., Handbook of Noise Measurement, 8th Edition, (1978), GenRad, Inc., Concord, Mass, Figure 2-1, p.6.

CHAPTER 3

NOISE MONITORING EQUIPMENT USED

The noise monitoring configuration used in the field surveys consists of three separate noise monitoring stations. Two of the stations use Bruel and Kjaer (B&K) Model 2233 Precision Integrating Sound Level Meters (ISLM) to record Leq, Lmax, and SEL values of single events and also for some ambient noise measurements. The B&K ISLMs are manufactured to meet Type 1 precision standards. Both ISLMs are connected to B&K Model 2619 preamplifiers and B&K Model 4155 1/2 inch prepolarized condenser microphone cartridges with a free-field frequency response from 4Hz to 16KHz. The third station uses a GenRad 1945 Community Noise Analyzer (CNA) connected to a P-42 condenser microphone preamplifier and 1/2 inch GenRad condenser electret microphone.

The DC output of each ISLM and the CNA is used to drive Easterline Angus Miniservo Model Graphic Level Recorders (GLR) at each station and produce a graphical time-history record of sound pressure level (SPL). The GLRs include a paper transport which is set to a speed of five centimeters per minute for these tests.

Microphones at each station are mounted for grazing incidence (i.e., parallel to the ground) four feet above the ground on modified Veblon camera tripods. Each tripod was modified by removing the camera mounting pan head, and attaching a thin metal "C"-clamp of the type commonly used to hold glass apparatus in chemical laboratories. The "C"-clamp is used to hold the microphone perpendicular to the vertical bar of the tripod. The modifications are designed to minimize reflection of sound waves from the tripod to the microphone. Each microphone is connected to its ISLMs or CNA by a three meter shielded cable. Ninety millimeter diameter porous polyurethane sponge windscreens are fitted over the microphones to minimize the effect of wind on the measurements. A schematic diagram of the layout of the three stations and their equipment is shown in Figure 3.1.

The ISLMs and their GLRs are calibrated using B&K model 4230 pistonphone type sound level calibrators producing a steady 94dB sound pressure at 1000Hz. The CNA and its GLR are calibrated using a GenRad model 1562 Sound Level Calibrator. The calibrators were themselves calibrated 2 weeks prior to this study.

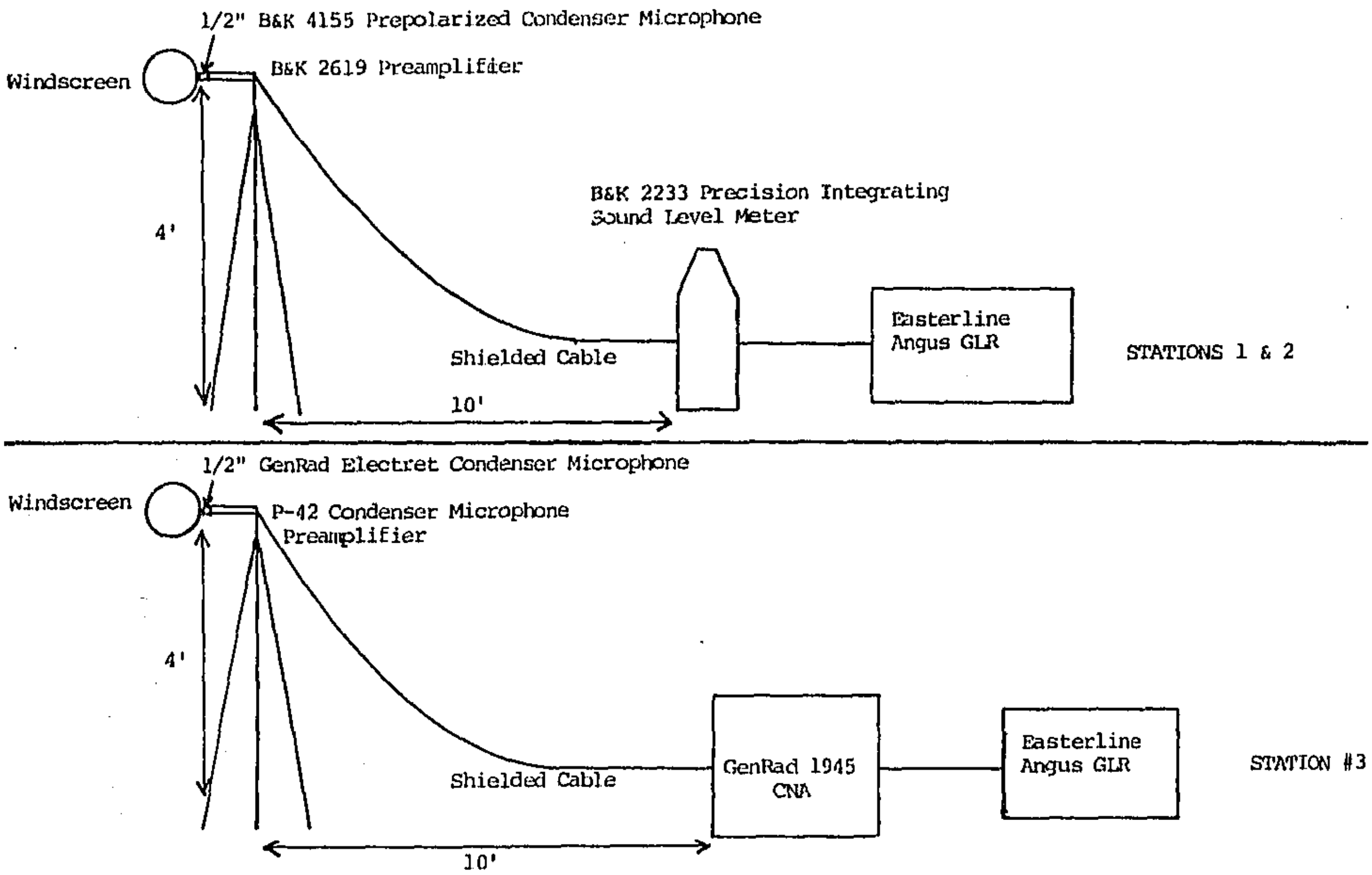


Figure 3.1 Schematic Drawing of Noise Monitoring Station Set Up

Chapter 4

Results of the Helicopter Noise Survey In Long Beach, California

This chapter presents the results of helicopter noise tests performed in Long Beach, California, and noise measurements of helicopters not involved in the tests in the vicinities of Long Beach Airport, John Wayne Airport and the Marine Helicopter Training Base in Irvine. It is divided into three sections. Section 4.1 presents a general overview of helicopter operations in the Long Beach area. Section 4.2 presents noise measurement data obtained from standardized helicopter maneuvers at three Long Beach helipad sites and the land use characteristics of each site. Section 4.3 presents the noise measurement data obtained from monitoring actual in-service helicopter operations.

4.1 OVERVIEW OF HELICOPTER OPERATIONS IN LONG BEACH

Based on data obtained from helicopter operators, airport and city officials, there are currently approximately 18,000 helicopter operations a year to and from the Long Beach airport. In addition, there are close to 100,000 training operations a year solely within the airport boundaries. This compares with our reported 84,917 training operations at the airport in 1979. In addition, there were 20,190 flyovers reported. Training operations usually involve several circular flight patterns with touch and go operations. (Final Subsequent Environmental Impact Report, Vol. II, prepared by Community and Environmental Planning Division, Department of Planning and Building, City of Long Beach, 1979.)

There are fifteen permanent helipads located in the Long Beach area. Figure 4.1 shows the locations of these helipads. Locations 1 - 8 are at the Long Beach Airport. Locations 1 - 5 are helipads owned by private helicopter companies providing a range of services such as pilot training, maintenance and repair, FAR 135 charter services, cargo and crew transport, and heavy lifting in construction. Locations 6, 7, and 8 are helipads owned and operated by city and county police departments whose operations are primarily devoted to traffic monitoring and search and rescue operations. There are approximately 30-40 helicopter operations a day from these eight helipads combined. Although these are not public use helipads, most will accept transient helicopter operations if arrangements are made in advance. Transient operations are, however, not very frequent. Noise measurements were obtained for the standardized helicopter maneuvers at Locations 2, 4, and 6.

Locations 9 and 10 are private corporate helipads owned by McDonnell Douglas and Hughes Aircraft, respectively. Operations at these locations primarily involve transport of executive personnel and are fairly infrequent with an average of approximately one operation a day. Locations 11 and 12 are hospital helipads used for emergency ambulance service. Because the frequency of medical emergencies is very irregular, the numbers of operations at these helipads vary considerably.

Locations 13 and 14 are privately owned helipads used in providing sightseeing services for tourists and in ferrying oil crews and equipment between the mainland and the offshore oil islands. The number of operations at both of these helipads combined varies from 20 to 30 per day, about half of them to service the oil islands. The helipad at Location 15 is operated by Southern California Edison and averages approximately one operation a day. There are also one or two temporary helipads at construction sites along the waterfront.

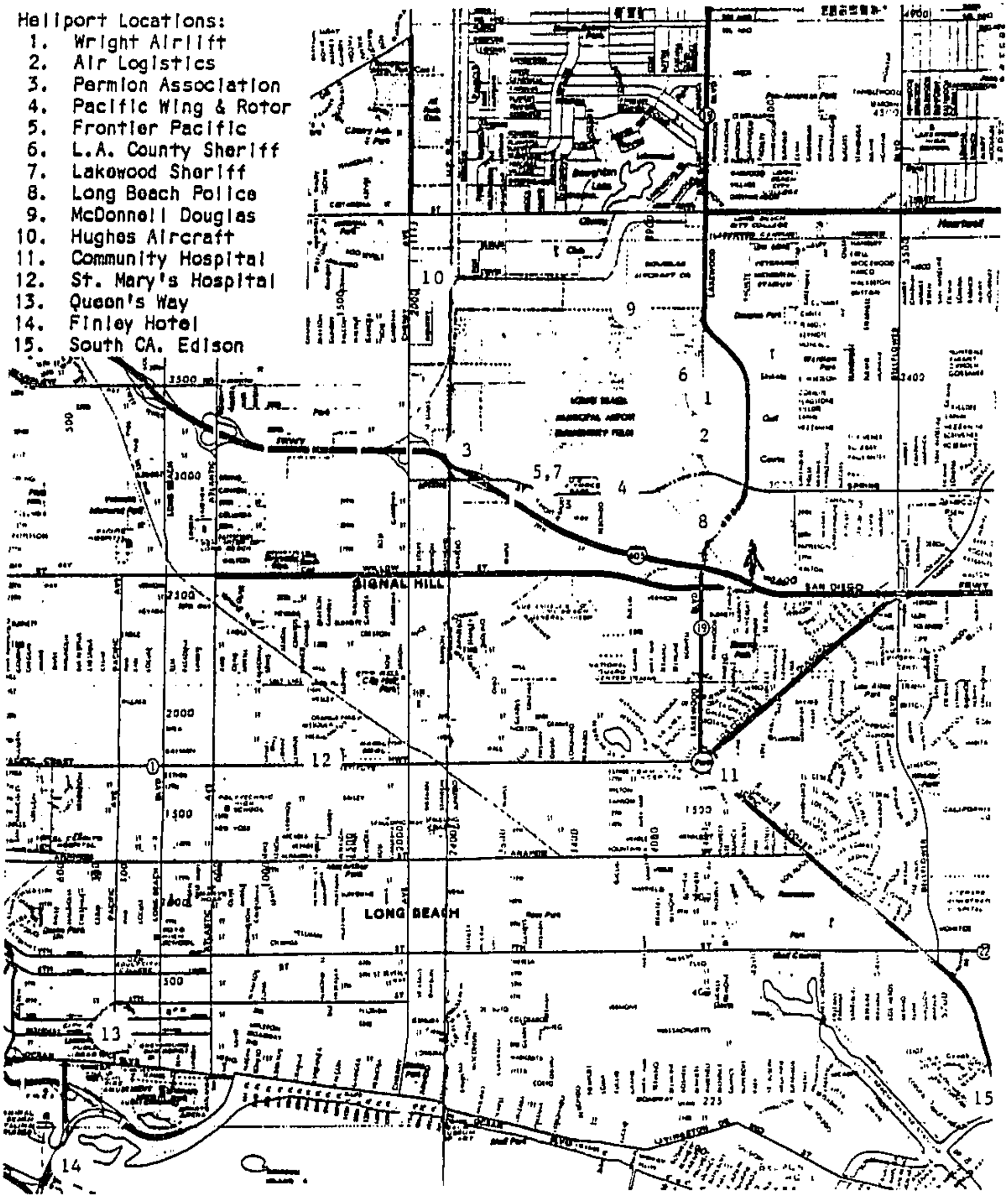


Figure 4.1 Locations of Heliports in Long Beach

4.1.1 Helicopter Related Noise Complaints

The Long Beach Airport Noise Abatement Office maintains a log of all aircraft noise complaints to airport. Noise complaints related to helicopter operations tend to be concentrated in the immediate vicinity of the prescribed helicopter flight paths near the airport. Noise complaints are also received occasionally from areas further away from the airport and the recommended flight paths. Usually, these complaints are traced to transient helicopters whose pilots are not familiar with the prescribed routes.

Table 4.1 shows the total number of noise complaints received for all aircraft by the airport for each of the months from September to December, 1983. Of these, 31 related to helicopter noise, 13 percent of the total.

The number of complaints is not necessarily a reliable indicator of helicopter noise impact. For example, for the month of September as many as half of the helicopter related noise complaints were from one individual. In addition, at times different members of the same household complained about noise from a single helicopter event.

Table 4.1

NUMBERS OF NOISE COMPLAINTS RECEIVED AT LONG BEACH AIRPORT
FROM SEPTEMBER TO DECEMBER, 1983

Event	September	October	November	December
Helicopter	12	9	5	5
Commercial	32	19	28	12
General Av.	39	31	22	14
Military	3	2	1	1
Training/Test	1	-	1	1
Total	87	61	57	33

- = Data Not Available

Source: Noise complaint log records maintained by Long Beach Airport, Noise Abatement Office.

4.1.2 Noise Abatement Procedures

Partly in response to numerous helicopter-related noise complaints in the past, the airport officials have established detailed helicopter flight procedures and flight paths designed to minimize the impact of helicopter noise on the surrounding community as well as to separate helicopter traffic from fixed-wing aircraft for safety. These procedures are formalized in Letters of Agreement which all eight helicopter companies located at the airport have signed. A copy of the Letter of Agreement and a Revised Agreement are attached as Appendix A.

The Letter of Agreement specifies four flight routes to be used under normal operating conditions into and out of the airport: one to the west along West Wardlow Avenue; one to the east along East Wardlow Avenue; one to the north over the Lakewood Country Club and one to the south along Redondo Avenue. Figure 4.2 shows a diagram indicating the four prescribed helicopter flight paths.

Before departing the airport, helicopter pilots are required to climb to an altitude of 500 feet using a circular flight pattern. Figure 4.3 shows these flight patterns within the airport boundaries as well as the locations of helipads in the airport. Approaching helicopters also are required to use the circular flight patterns when descending to a helipad and are supposed to maintain an altitude of 500 feet until they are within the airport boundaries.

It appears that these prescribed procedures are generally followed, but there are occasional instances where a pilot may "cut corners" and begin his approach descent a little early, or not follow the looping pattern and approach straight in.

4.1.3 Description of Land Use In the Vicinity of Long Beach Airport.

Long Beach Airport, where the three helipads used for the standardized maneuver tests are located, is on the northern boundary of Long Beach city limits. The city limits of Long Beach extend to the northwest, west, south and east of the airport. The town of Lakewood borders the airport to the north, and the small town of Signal Hill is located to the southwest. The map in Figure 4.4 is shaded to show land use in the vicinity of the airport as well as indicating the locations of the heliports in the Long Beach area. It also shows the four main

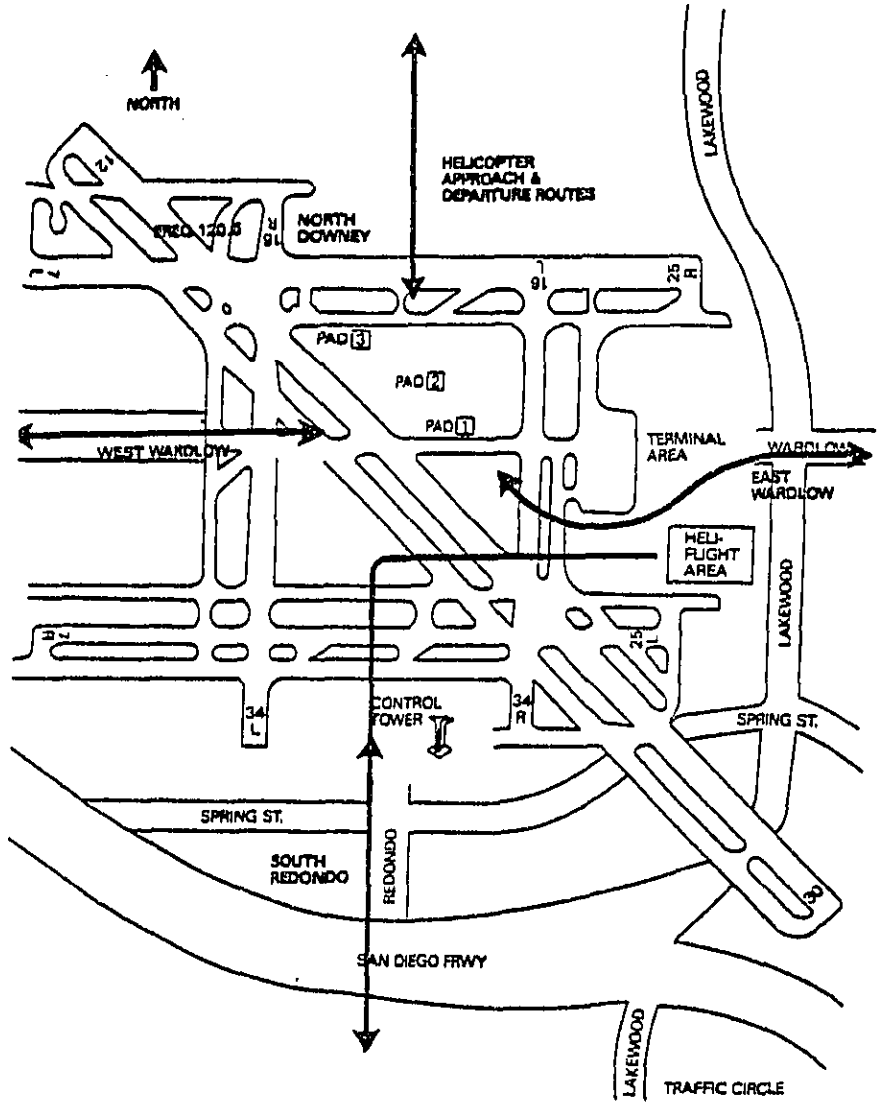
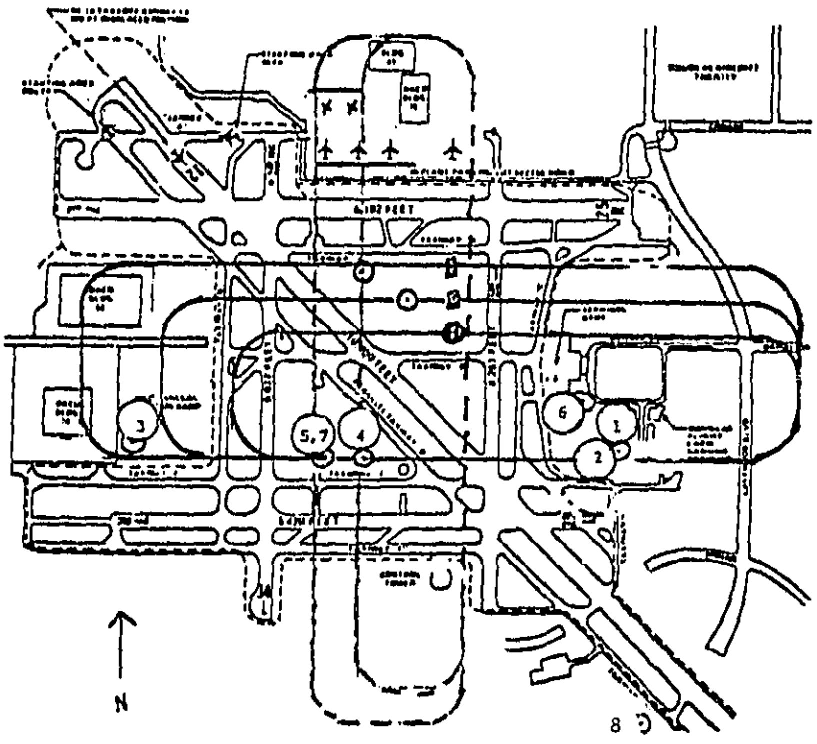


Figure 4.2 Diagram of Helicopter Approach and Departure Routes Outside Long Beach Airport Boundaries



Legend:

1 = Wright Airlift
2 = Air Logistics
3 = Permian
4 = Pacific Wing and Rotor
5 = Frontier Pacific
6 = L.A. County Sheriff
7 = Lakewood Sheriff
8 = Long Beach Police Department

Existing Pads

Proposed Pad/Lane Sites

West Traffic

Figure 4.3 Diagram of Helicopter Flight Paths Within Long Beach Airport Boundaries

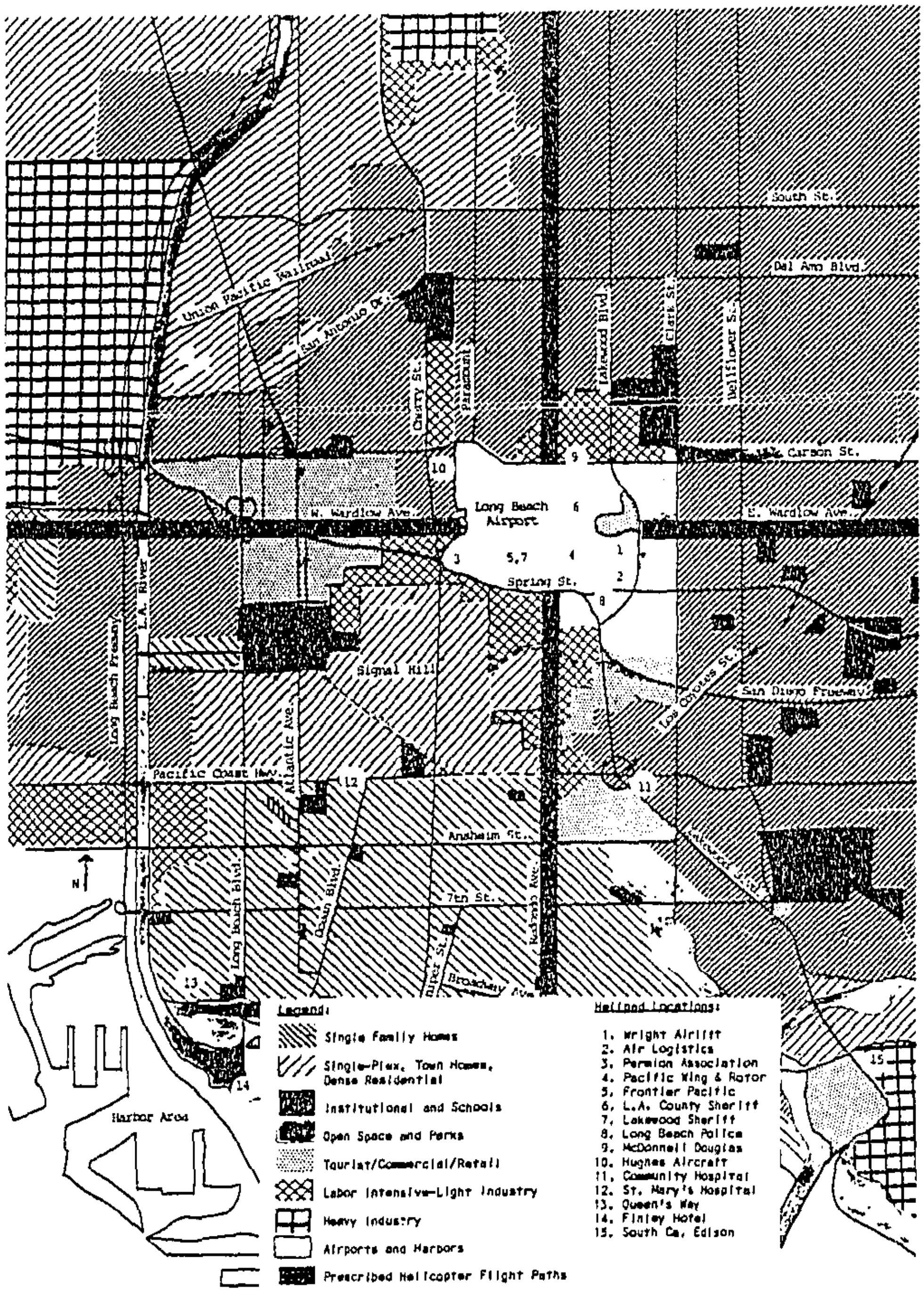


Figure 4.4 Descriptions of Land Use Characteristics for Long Beach

flight corridors used by helicopters approaching and departing from the airport. The four flight corridors are indicated by broad-width black arrows on the map.

The immediate area around the airport for two to three blocks on the northeast, north, west and south consists of light commercial and retail companies and some labor intensive industries (primarily the Hughes Aircraft and McDonnell Douglas aircraft manufacturing plants). However, land use in the general vicinity of Long Beach Airport is mainly residential. An area two miles wide extending to the east and southeast of the airport consists mainly of single family detached homes with some large open areas of parks and golf courses, and several schools, churches, and hospitals. Helicopter traffic traverse this area along the East Wardlow Avenue flight corridor (indicated on the map by the solid black arrow to the west). It was noted during noise monitoring that helicopters circling to gain altitude at the helipads on the airport's eastern perimeter sometimes stray into the golf course area east of Lakewood Blvd. In addition, helicopters approaching from the east would cut across the golf course as they begin their approach descent into the airport.

The town of Lakewood lies to the north of the airport. This area is mainly composed of large, single-family detached homes. It also includes two country clubs and a large shopping mall. A number of complaints have been received from this area in the past. As a result of these complaints, use of the northern helicopter flight corridor (indicated by the solid black arrow to the north) is discouraged by the airport management. The management recommends, instead, that northern departures leave to the west and proceed north along the Los Angeles River and that approaches from the north fly along the Los Angeles river and approach the airport from the west.

Northwest and west of the airport, land use is primarily medium-income, single-family homes; single-plex homes; townhomes; and some pockets of high density residential development. Less open park space exists here than to the east and north. The only example large enough to indicate on the map is a narrow strip along raised banks of the the Los Angeles River. Some heavy industrial pockets are located in the northwest corner of Long Beach.

The area to the west of the airport consists primarily of commercial/retail and light industry. Fewer helicopter-related noise complaints are received from this area than from other areas near the airport.

The land area to the south of the airport, extending to the Pacific Ocean, consists primarily of low to middle-income townhomes with some small pockets of dense low-income residential development. A small area of heavy industry is located in the southeast corner of Long Beach. The city government offices and convention center are located on the southern fringes next to the Pacific Ocean beach area which runs east to west along the southern boundary. A large harbor area and several tourist attractions are located in the southwest corner of Long Beach. Complaints of helicopter noise have been received, occasionally, from residential areas three to four miles south of the airport along the South Redondo Ave. helicopter flight corridor (indicated by the solid black arrow to the south of the airport.) In addition some complaints originate along the shoreline where some helicopters using the South Redondo Ave. flight corridor make their turns east or west along the coastline.

4.2 STANDARDIZED MANEUVER TESTS

Three helicopter models performed the standardized maneuver in noise tests at Long Beach: a Bell 206L, a Hughes 300B, and a Robinson 22. Manufacturers' specifications for these helicopters are shown in Appendix B. The tests were conducted at three helipads located at the Long Beach Airport: the Air Logistics and the Los Angeles County Sheriff's Aero Bureau helipads located on the eastern perimeter of the airport, and the Pacific Wing and Rotor helipad located on the southern perimeter of the airport. This section describes how the noise monitoring stations were placed at each of the sites, the helicopter test maneuvers, and the noise measurement data obtained.

4.2.1 Air Logistics

Air Logistics operates a Bell 206L helicopter from its helipad and maintenance facility on the eastern perimeter of Long Beach Airport. Land use in the vicinity of the helipad and the airport was shown in Figure 4.4.

Three noise monitoring stations were set up along a straight line extending east from the helipad at distances of 188 feet, 403 feet, and 626 feet. Figure 4.5 shows the locations of the noise monitoring stations in relation to the helipad, as well as the flight path used on the takeoff and approach maneuvers. Station 1 was located on an asphalt surface on the Air Logistics site. Stations 2 and 3 were set up across the street (Lakewood Boulevard) on a golf course. The traffic volume on Lakewood Boulevard was light to moderate and consisted mainly of automobiles, with some buses and heavy trucks. Because the helipad is on airport property there was noise from aircraft and helicopter operations as well as from the test helicopter during

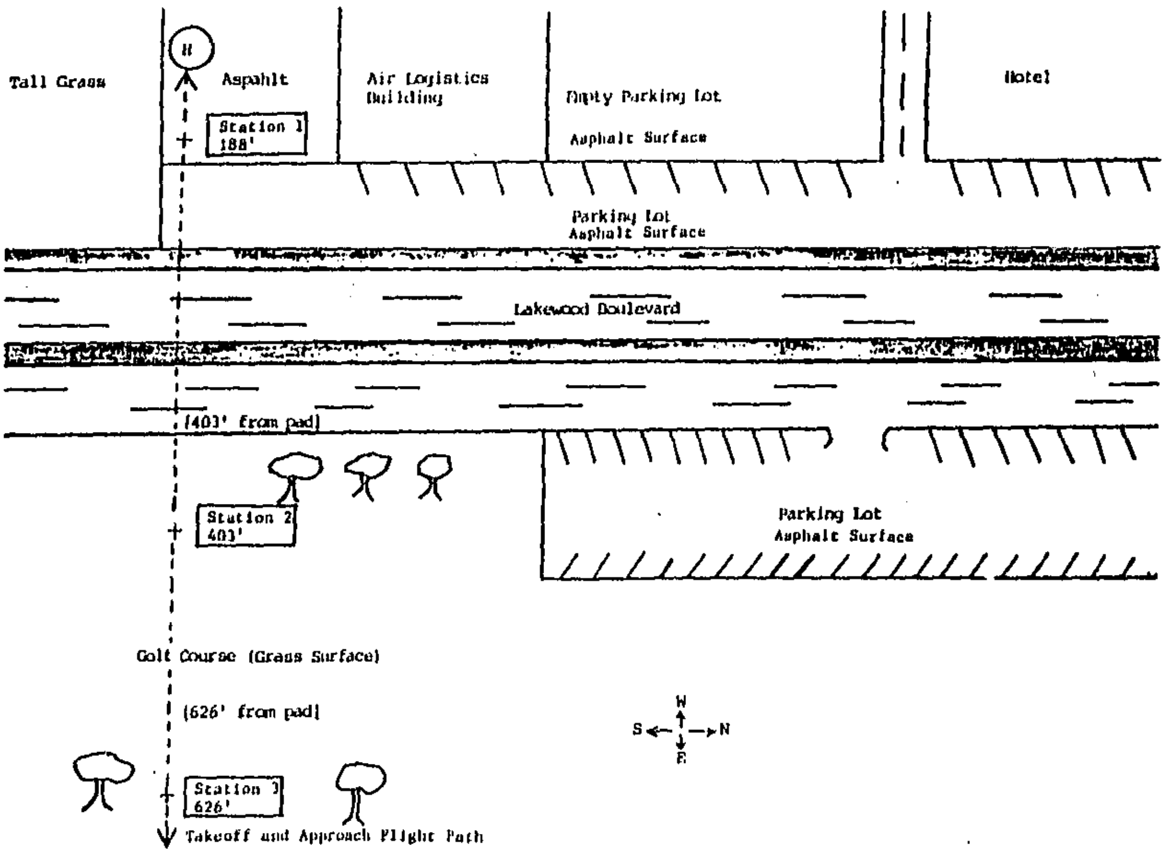


Figure 4.5 Site Schematic for Air Logistics Test Site

some of the measurements. Most of the fixed-wing aircraft operations were light general aviation aircraft, carrier heavy jets, mostly Boeing 727s. The mix of airport operations contributed to high ambient noise levels particularly during daylight hours when the hourly numbers of operations were highest.

The Air Logistics pilot, using the Bell 206L, performed the following maneuvers in the order listed:

1. Approach, from east;
2. 100% takeoff throttle, flat pitch, west;
3. Hover, west;
4. Hover, south;
5. 100% takeoff throttle, flat pitch, east;
6. Hover, east;
7. 100% flat pitch, idle, east;
8. Hover, east;
9. Takeoff, to east ("normal" case)
10. Takeoff, to east ("worst" case).

Table 4.2 shows the noise levels recorded during the helicopter test maneuvers at the three measurement stations. The helicopter pilot performed two takeoffs -- one "normal case" (i.e. with a relatively steep ascent angle); and one "worst case" (i.e. with a relatively shallow ascent angle). Lmax values recorded at Stations 2 and 3 were 3dB(A) to 5dB(A) higher for the worst case takeoff than for the normal case. The higher Lmax values recorded at Stations 2 and 3 are in the worst case takeoff attributable to the low altitude of the helicopter as it flew over these stations. The helicopter was at approximately the same altitude over Station 1 for both the "normal" and the "worst case" takeoffs. Stations 1, 2 and 3 indicated similar Lmax values for the approach as for the "normal" takeoff. The charts of SPL measured at Stations 1, 2 and 3 during the tests are shown in Figures 4.6, 4.7, and 4.8, respectively.

TABLE 4.2 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT AIR LOGISTICS

Location: Air Logistics
Date: January 31, 1984
Time: 8:30 a.m.
Helicopter Model: Bell 206-L

Temperature: 60 F
Relative Humidity: 45
Wind Speed: 1 - 3 knots

Station	Dist. From Pad (ft.)	Approach[1]				100% Idle (West)				Hover(West)				Hover (South)				100% Idle (South)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	106	34	87.4	102.7	95.2	21	83.7	96.6	86.1	31	90.2	105.1	94.1	34	86.0	101.1	90.7	30	85.3	101.1	87.0
2	403	-	-	-	80.0	-	-	-	75.0	-	-	-	83.0	35	74.3	89.7	78.1	-	-	-	76.0
3	826				80				65				72				85				68

Station	Dist. From Pad (ft.)	Hover (East)				100% Idle (East)				Hover (East)				Takeoff 1[2][3] Normal Case				Takeoff 2[4][5] Worst Case			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	106	33	83.3	89.0	86.6	44	80.9	87.3	82.6	36	82.2	97.8	93.5	53	95.8	102.8	94.5	-	-	-	94.5
2	403	-	-	-	74.0	-	-	-	75.0	38	69.9	85.7	71.0	35	82.1	97.6	86.0	21	82.5	95.7	89.8
3	626				66				81				63				80				85

All noise data were recorded with A-frequency weighting and slow response time averaging.
- = No data obtained due to equipment malfunction.
[1] = Helicopter estimated at 50' altitude directly over Station 1 (visual judgement).
[2] = Normal case is steep ascent angle.
[3] = Helicopter estimated at 50' altitude directly over Station 1 (visual judgement).
[4] = Worst case is gradual ascent angle.
[5] = Helicopter estimated at 50' altitude directly over Station 1 (visual judgement).

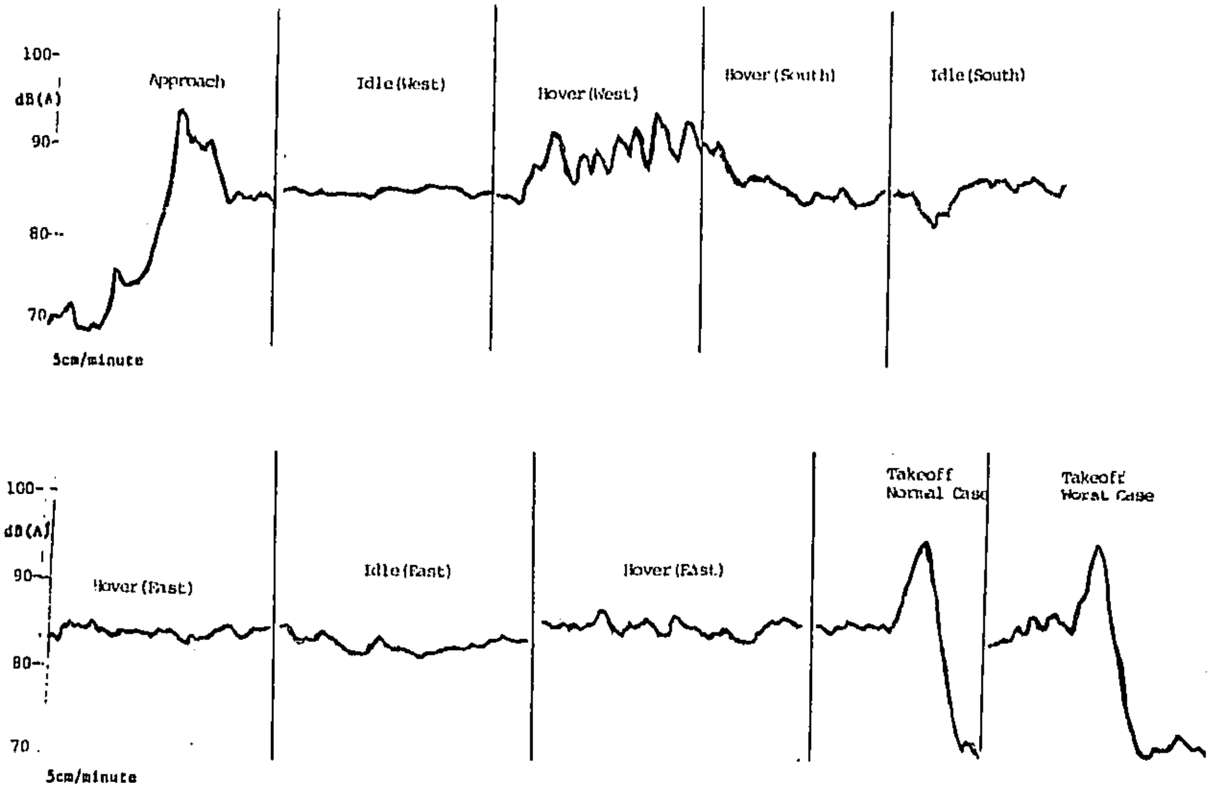


Figure 4.6 GLR Output for Air Logistics Test - Station 1

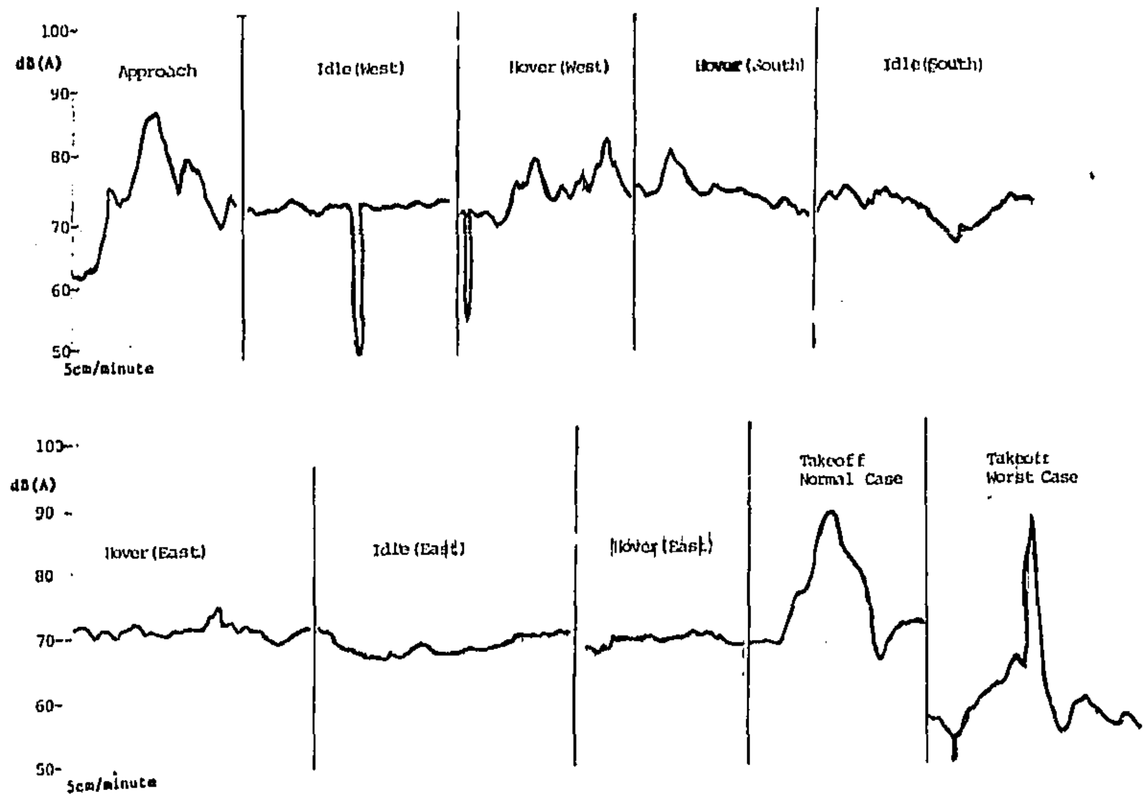


Figure 4.7 GLR Output for Air Logistics Test - Station 2

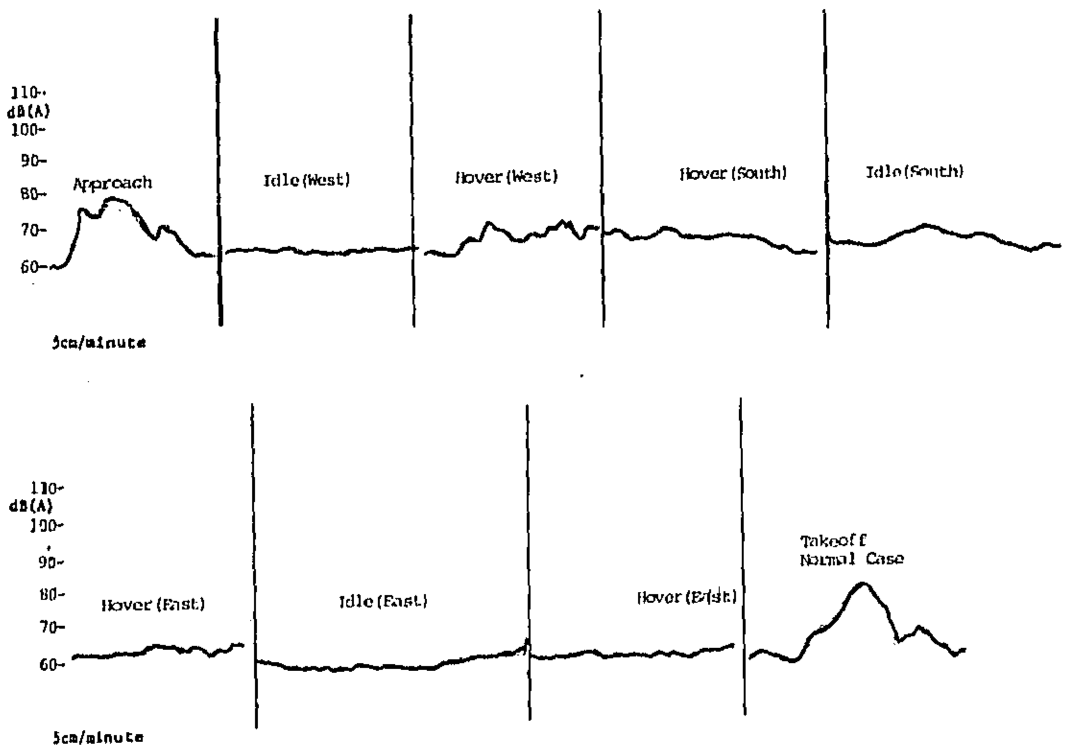


Figure 4.8 GLR Output for Air Logistics Test - Station 3

Table 4.3 shows ambient noise data recorded at Station 3 for two consecutive one-hour sample periods. The first sample period included the Bell 206L helicopter test maneuvers while the second sample period did not. Due to the large number of fixed wing aircraft and other helicopter operations occurring during both sample periods, ambient noise levels with and without the test helicopter's operations were very similar: that is, the helicopter tests had little effect on the ambient noise level.

Table 4.4 shows Lmax values recorded at Station 3 during the ambient noise sample periods for selected intrusive noise incidents and the Lmax values recorded during the helicopter test maneuvers. General Aviation landings occurred at two parallel runways approximately 1500 feet on either side of the noise measurement array. Jet landings and takeoffs occurred at a runway perpendicular to the noise measurement array approximately 2000 feet in front of the station. Automobile and truck traffic was present on Lakewood Boulevard approximately 250 feet from the station.

Maximum sound levels recorded at Station 3 for GA landings, GA flyovers, jet landings, jet takeoffs, and automobile and truck traffic ranged from 53dB(A) to 76dB(A). Maximum sound levels during the helicopter tests ranged from 61 dB(A) to 85 dB(A).

4.2.2 Los Angeles Sheriff's Aero Bureau

The Los Angeles Sheriff's helipad and maintenance facility is located on the eastern perimeter of Long Beach Airport, immediately to the north of the Air Logistics Facility. The golf course lies to the east on the opposite side of Lakewood Boulevard. The facility is indicated as helipad no. 6 in the map in Figure 4.4 which shows land use in the area surrounding the airport.

TABLE 4.3 AMBIENT NOISE LEVELS AT AIR LOGISTICS

Location: Air Logistics (Station 3)
Date: January 31, 1984
Time: 9:34 a.m. - 11:47 a.m.
Helicopter Model: Bell 206-L

Temperature: 60 F
Relative Humidity: 45%
Wind Speed: 1 - 3 knots

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient with Bell 206-L Helicopter Operations	9:34-10:34	1 Hour	-	-	-	-	-	55	50	48	63	Includes 2 helicopter flyovers, 3 GA landings and 1 jet t.o.
Ambient without Bell 206-L Helicopter Operations	10:47-11:47	1 Hour	-	-	-	-	-	55	51	50	62	Includes 16 helicopter, 7 jet, and 5 GA operations.

All noise data were recorded with A-frequency weighting and slow response time averaging.
- = No data obtained due to equipment malfunction.

TABLE 4.4 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3 AIR LOGISTICS

Location: Air Logistics (Station 3)
Date: January 31, 1984
Time: 9:30 a.m. - 11:47 a.m.

Temperature: 60 F
Relative Humidity: 45%
Wind speed: 1 - 3 knots

Event	Lmax	Event	Lmax
Aircraft Operations:		Street Traffic:	
Jet Takeoff	68	Car backfire	67
Jet running engine	66	Tractor mower	67
Jet running engine	65	Bus	58
Jet takeoff	78	Tractor trailer	61
GA aircraft landing	59	Tractor trailer	59
Jet landing	72	Traffic accelerating	58
GA Landing	65	Traffic accelerating	60
Jet takeoff	76	Tractor trailer	58
GA Landing (single engine)	66	Tractor trailer	64
GA Landing (single engine)	61	Tractor trailer	64
GA Landing (2-engine)	67	Tractor trailer	60
Jet landing	63		
Jet reversing engine	64		
Jet takeoff	75	Tractor trailer	70
		Tractor trailer	65
In-Service Helicopter Operations:		Tractor tailer	65
		Tractor trailer	63
Helicopter flyover	64	Tractor trailer	62
Helicopter engine cooldown	57		
Hughes helicopter flyover	61	Helicopter Test Maneuvers:	
Helicopter flyover	62		
Helicopter flyover	62	Approach	60
Helicopter flyover	62	100% Idle(West)	65
Helicopter flyover	62	Hover(West)	72
Helicopter flyover	62	Hover(South)	66
Helicopter flyover	64	100% Idle(South)	68
Helicopter flyover	62	Hover(East)	66
Helicopter flyover	64	100% Idle(East)	61
Helicopter takeoff (to west)	68	Hover(East)	63
Helicopter flyover	62	Takeoff (Normal Case)	60
Helicopter flyover	60	Takeoff (Worst Case)	65
Helicopter flyover	61		
Helicopter flyover	63		
Helicopter flyover (directly overhead)	68		
Helicopter flyover (directly overhead)	68		

All noise data were recorded with A-frequency weighting and slow response time averaging.

Three noise monitoring stations were set up in a straight line at distances 174 feet, 433 feet, and 685 feet northeast from the helipad. The site schematic in Figure 4.9 shows the noise monitoring locations and surrounding area, as well as the flight paths used on the takeoff and approach noise test maneuvers. Stations 1 and 2 were located on an asphalt parking lot at the Los Angeles Sheriff's Aero Bureau. Station 3 was located on a grass surface in the golf course on the other side of Lakewood Boulevard. Background ambient noise levels at Station 3 were between 61 dB(A) and 65 dB(A). Intrusive noise sources came primarily from general aviation and commercial aircraft operations at Long Beach Airport.

The helicopter pilot at the Sheriff's Aero Bureau, using a Hughes 300B helicopter, performed the following maneuvers in the order listed:

1. Approach, from east;
2. 62% flat pitch, idle, west;
3. Hover, west;
4. Hover, south;
5. 62% flat pitch, idle, south;
6. Hover, east;
7. Takeoff, to east;
8. Approach, from east.

Table 4.5 shows the noise levels recorded during the test maneuvers at the three measurement stations. The takeoff and two approach maneuvers were executed directly over the noise measurement array. Noise from the idle (west), hover (south), idle (south), hover (east), and the second approach maneuvers was not detected at the most distant station, Station 3, because of the high levels of ambient noise during the tests. Lmax values recorded at Station 1 ranged from 75.5 dB(A) for Idle

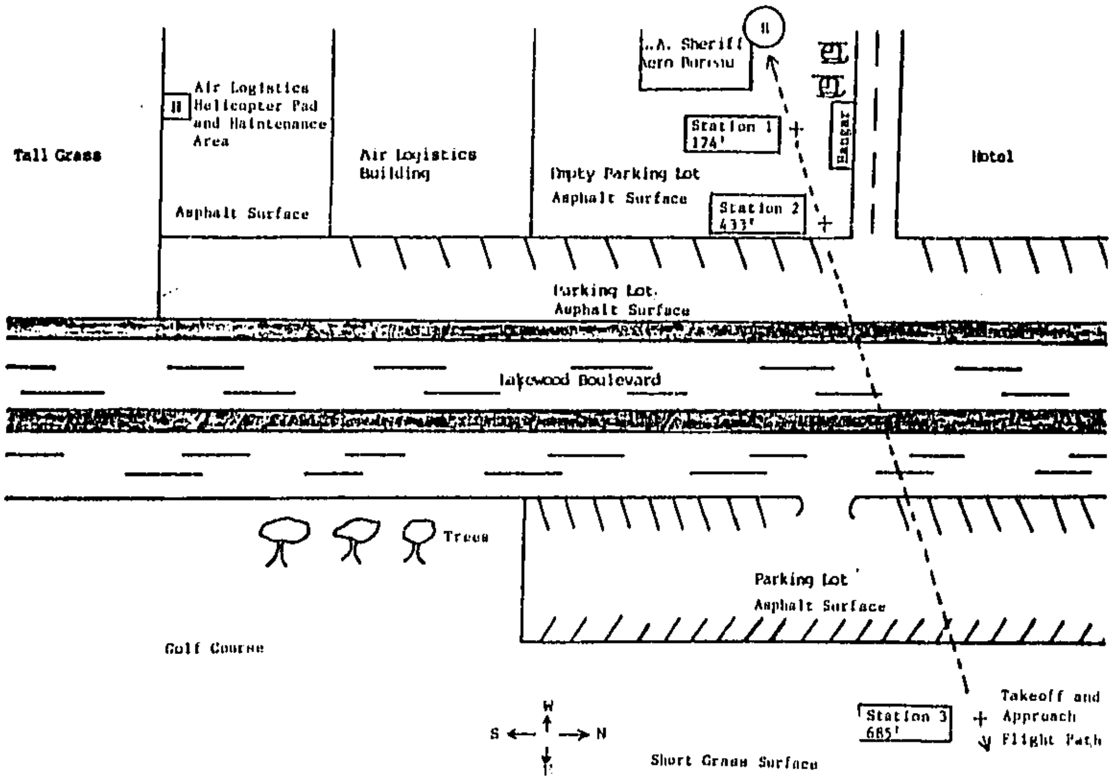


Figure 4.9 Site Schematic for L.A. Sheriff's Aero Bureau Test Site

TABLE 4.5 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT LOS ANGELES SHERIFF'S AERO BUREAU

Location: L.A. Sheriff's Aero Bureau
Date: February 1, 1984
Time: 9:30 a.m.
Helicopter Model: Hughes 300B

Temperature: 60 F
Relative Humidity: 45%
Wind Speed: 1 - 3 knots

Station	Dist. From Pad (ft.)	Approach [1]				62% Idle (West)				Hover (West)				Hover (South)				62% Idle (South)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	174	31	86.5	101.4	94.7	38	71.0	86.8	76.8	30	81.3	96.1	83.8	37	77.4	93.1	81.8	37	69.1	84.8	75.5
2	433	30	81.2	96.0	88.1	41	62.9	79.0	72.8	30	73.5	88.3	75.5	37	71.0	86.8	77.1	38	68.4	84.2	71.8
3	605				80				*				81				*				*

Station	Dist. From Pad (ft.)	Hover (East)				Takeoff [2]				Approach [3]			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	174	38	77.3	93.2	81.6	24	86.0	99.8	88.0	33	86.6	101.8	93.3
2	433	38	71.0	86.8	75.1	24	80.9	94.7	84.3	-	-	-	-
3	605				*				82				*

All noise data were recorded with A-frequency weighting and slow response time averaging.
* = No data obtained due to high background ambient noise.
[1] = Helicopter estimated at 41' altitude directly over Station 1.
[2] = Helicopter estimated at 100' altitude directly over Station 1.
[3] = Helicopter estimated at 60' altitude directly over Station 1.

(South) to 96.0 dB(A) during takeoff. At Station 2, Lmax values ranged from 71.6 dB(A) for Idle (South) to 88.1 dB(A) during Approach. SPL charts for Stations 1 and 3 are shown in Figures 4.10 and 4.11, respectively. An SPL chart for Station 2 was not obtained because of a malfunction in a graphic level recorder.

Table 4.6 shows ambient noise data obtained at Station 3 during five half-hour sample periods. The second half-hour sample period included the helicopter noise tests, while the other four sample periods did not. However, all of the ambient noise sample periods included several general aviation and commercial jet operations, as well as several in-service helicopter operations. For this reason, it has not been possible to determine the contribution of the helicopter noise tests produced from comparisons of the ambient noise measurements near the airport. However, even with the general aviation and commercial operations at the airport and moderate traffic on Lakewood Boulevard, the Leq levels at Station 3 were relatively low, ranging between 61 dB(A)-and 65 dB(A).

Table 4.7 presents selected Lmax values for intrusive noise not attributable to the helicopter test maneuvers recorded at Station 3 during the ambient noise sample periods, and Lmax values recorded during the helicopter test maneuvers. Most of the intrusive noise was from general aviation fixed-wing and helicopter operations and street traffic on Lakewood Boulevard. Lmax values recorded at Station 3 for in-service helicopter operations ranged from 63 dB(A) for a distant helicopter flyover to 85 dB(A) for a Hughes helicopter approach directly over the station. General aviation and commercial jet Lmax values ranged from 59 dB(A) for a small fixed-wing aircraft landing to 66 dB(A), also for a fixed-wing aircraft landing. Lmax values recorded at Station 3 for street traffic on Lakewood Boulevard ranged from 55 dB(A) for a passing car to 70 dB(A) for a large

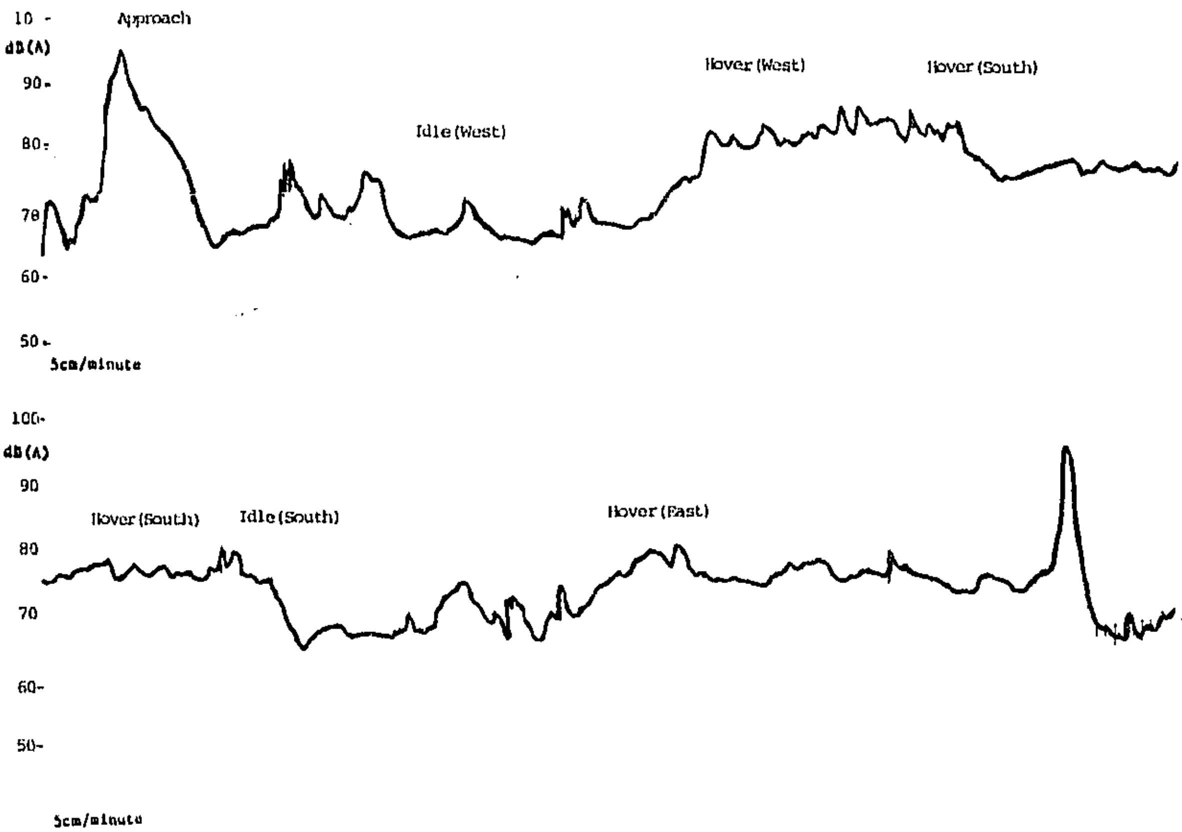


Figure 4.10 GLR Output for L.A. Sheriff's Aero Bureau Test - Station 1

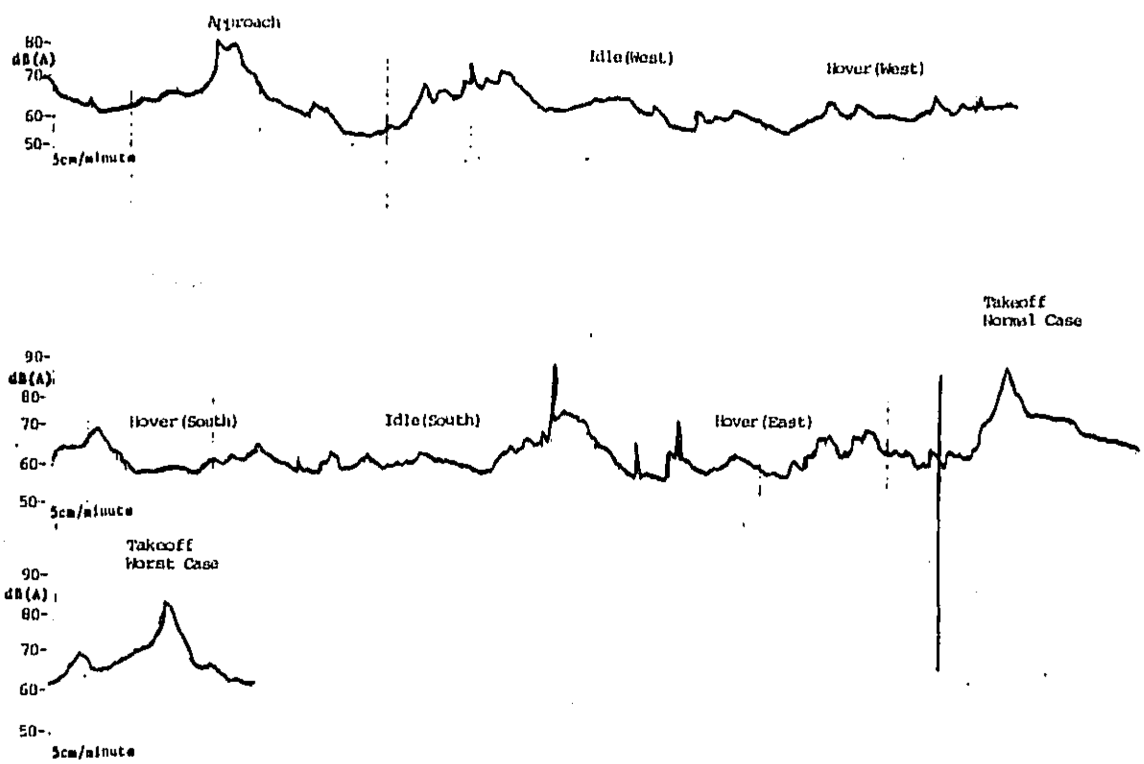


Figure 4.11 GLR Output for L.A. Sheriff's Aero Bureau Test - Station 3

TABLE 4.6 AMBIENT NOISE LEVELS AT LOS ANGELES SHERRIF'S AERO BUREAU

Location: L.A. Sheriff's Aero Bureau (Station 3)
Date: February 1, 1984
Time: 8:58 a.m. - 11:58 a.m.
Helicopter Model: Hughes 300B

Temperature: 60 F
Relative Humidity: 48%
Wind Speed: 8 knots at 180

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient without test operations	8:58-9:28	1/2 hour	-	-	78	62	56	53	50	49	-	5 helo flyovers, 1 jet t.o.
Ambient with test operations	9:30-10:00	1/2 hour	82[1]	82	77	67	58	54	52	52	65	8 helo flyovers, 3 jet t.o.
Ambient without test operations	10:12-10:42	1/2 hour	76[2]	75	72	64	58	53	51	50	61	2 helo flyovers, and 4 jet t.o.
Ambient without test operations	10:52-11:22	1/2 hour	75[3]	75	73	68	57	53	52	51	64	12 helo flyovers, 1 jet t.o., 2 g.a. land.
Ambient without test operations	11:28-11:58	1/2 hour	85[4]	84	78	66	57	54	51	49	65	6 helo flyovers, 2 g.a. landings. 1 jet t.o.,

All noise data were recorded with A-frequency weighting and slow response time averaging.
[1] = Lmax recorded from test helicopter t.o. maneuver (visual judgement).
[2] = Lmax recorded from Hughes 300B helicopter flyover 600 feet in front of Station 1 at 500 feet altitude (photo scaling).
[3] = Lmax recorded from jet takeoff from Long Beach Airport.
[4] = Lmax recorded from Hughes 300B helicopter landing at L.A. Sheriff's Office directly over Station 3.

TABLE 4.7 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3
LOS ANGELES SHERIFF'S BUREAU

Location: L.A. Sheriff's (Station 3)
Date: February 1, 1984
Time: 8:58 a.m.- 11:58 a.m.

Relative Humidity: 48%
Wind Speed: 9 knots at 180

Event	Lmax
Aircraft Operations:	
Jet takeoff	67
Jet takeoff	73
Jet takeoff and helicopter flyover	68
GA Jet flyover	82
Jet takeoff	68
Jet takeoff	73
GA Jet takeoff	85
Jet takeoff	74
GA Landing	68
GA Landing	50
Jet Landing	50
Jet takeoff	75
Jet takeoff	70
GA twin engine takeoff	73
In-Service Helicopter Operations:	
Helicopter flyover	67
Helicopter circled and turned to airport	64
Helicopter flyover	72
Helicopter flyover	69
Helicopter flyover	75
Helicopter flyover	65
Helicopter flyover directly overhead	75
Helicopter flyover	71
Helicopter flyover	63
Helicopter flyover	76
Bell helicopter takeoff	77
Hughes 500C turning behind station	78
Helicopter turning directly overhead	75
Hughes helicopter approach directly overhead	85
Helicopter flyover	66
Helicopter flyover	66
Hughes helicopter takeoff to South	65
Police helicopter takeoff to South	67
Police helicopter flyover at 500' altitude	76
Helicopter flyover and turn to airport	74
Helicopter flyover	73
Hughes 500C helicopter flyover	74
Helicopter flyover at 500' altitude	72
Helicopter flyover turning directly overhead	75
Helicopter flyover at 500'' altitude directly overhead	73
Hughes 500C helicopter turning direcly overhead	75
Helicopter flyover turning directly overhead	73
Helicopter flyover directly overhead	74
Street Traffic:	
Truck	62
Truck	62
General street traffic	63
Truck	68
Helicopter Test Maneuvers:	
Approach	80
Hover(West)	81
Takeoff	82

All noise data were recorded with A-frequency weighting and slow response time averaging.

truck. By comparison, those helicopter test maneuvers that could be detected above the ambient noise levels registered Lmax values between 61 dB(A) for the hover facing west maneuver to 82 dB(A) for the takeoff.

4.2.3 Pacific Wing and Rotor

Pacific Wing and Rotor operates a helipad and helicopter maintenance facility on the southern perimeter of Long Beach Airport. Land use immediately south and west of the helipad is mainly light manufacturing and commercial. Figure 4.3 shows additional land use details for the location.

Figure 4.12 shows the locations of the test helipad and the monitoring stations with respect to the surrounding area. The helipad and Stations 1 and 2 were located in a straight line on the concrete general aviation parking area south of the southern taxiway. Station 1 was 254 feet from the helipad and Station 2 was 409 feet from the helipad. (Station 3, with the Community Noise Analyzer, was not used.) Several light fixed-wing aircraft were parked 50 to 75 feet south of the monitoring stations.

Intrusive noise came primarily from aircraft operations at the airport and from intermittent bulldozing on a small tract of land 300 to 400 feet south of Station 2.

The helicopter pilot at Pacific Wing and Rotor, using a Robinson 22 helicopter, performed the following two maneuvers in the order listed:

1. 100% takeoff throttle, flat pitch, facing north;
2. Takeoff, to west.

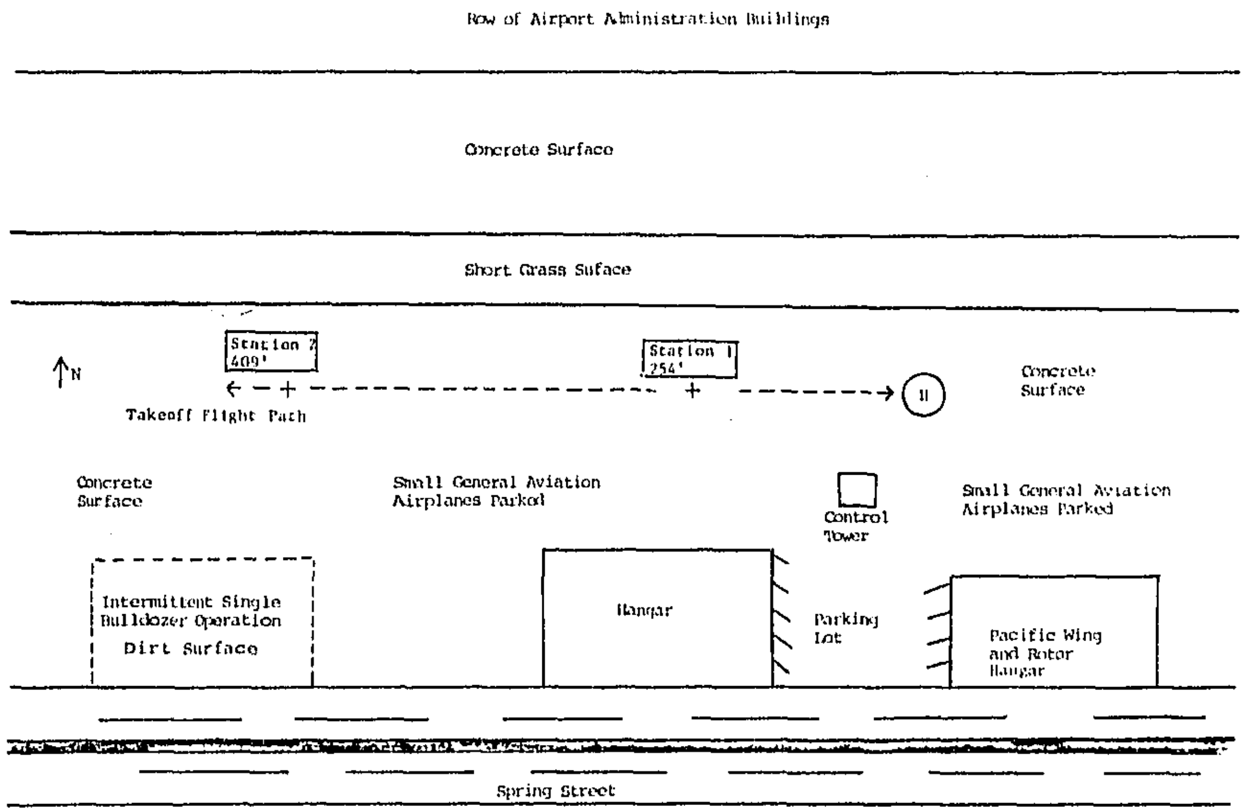


Figure 4.12 Site Schematic for Pacific Wing and Rotor Test Site

Table 4.8 shows the noise levels recorded during the helicopter test maneuvers at the two measurement stations. The takeoff maneuver was executed directly over the noise measurement array. The ascent angle used on the takeoff maneuver was relatively shallow as is indicated by the similar Leq and Lmax values recorded at the two stations. The SPL charts for Stations 1 and 2 are shown in Figure 4.13.

Table 4.9 shows ambient noise data obtained at Stations 1 and 2 using integrated precision sound level meters. The first three sample periods did not include any aircraft operations, neither helicopter nor fixed-wing. Lmax levels for these periods were in the range 60.2 to 65.6 dB(A) and Leq levels ranged from 57.7 to 58.3 dB(A). SEL measures the total sound energy recorded during each period. SEL for the first three periods ranged from 71.5 to 73.2 dB(A).

Data for the fourth period reflect the effect of a takeoff by a small fixed-wing aircraft. The fifth and sixth periods each included a helicopter flyover. The fixed-wing takeoff resulted in a Lmax value of 72.0 dB(A), and the helicopter operations resulted in Lmax values of 68.9 dB(A) and 70.1 dB(A) respectively. Leq for each of these three periods ranged from 62.2 dB(A) to 65.1 dB(A). However, because the noise during each of these periods varied considerably in intensity and the duration of the periods were not constant, the Leq values are not directly comparable. A better comparison is afforded by the SEL results. They show that the total noise energy recorded during each of the last three periods was similar: SEL values were in the range 78.8 dB(A) to 80.4 dB(A), about 8 dB(A) higher than in the first three periods when there were no observed aircraft noise events.

TABLE 4.8 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT PACIFIC WIND AND ROTOR

Location: Pacific Wing and Rotor
Date: February 1, 1984
Time: 4:00 p.m.
Helicopter Model: Robinson 22

Temperature: 65 F
Relative Humidity: 45%
Wind Speed: 1 - 3 knots

Station	Dist. From Pad (ft.)	Idle (North) Time (sec.)	Idle (North) Leq	Idle (North) SEL	Idle (North) Lmax	Takeoff [1] Time (sec.)	Takeoff [1] Leq	Takeoff [1] SEL	Takeoff [1] Lmax
1	254	27	67.1	80.8	68.1	16	85.3	97.3	92.3
2	400	16	64.1	76.1	67.1	17	83.2	95.5	90.8

All noise data were recorded with A-frequency weighting and slow response time averaging.
[1] = Helicopter estimated at approximately 100' altitude directly over Station 2 (visual judgement).

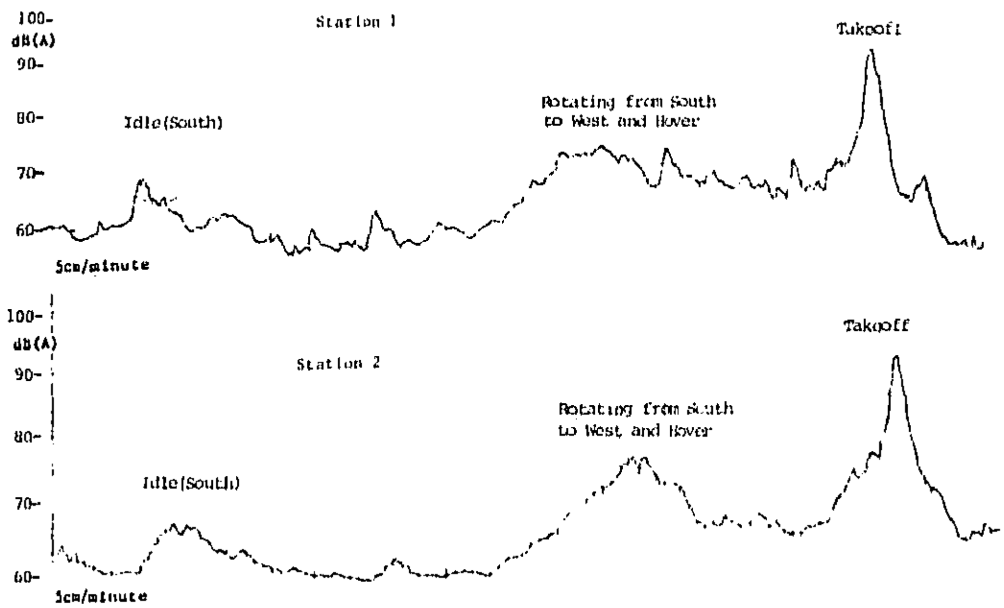


Figure 4.13 GLR Output for Pacific Wing and Rotor Test - Stations 1 and 2

TABLE 4.9

EFFECTS OF LIGHT FIXED-WING
AND HELICOPTER OPERATIONS
ON AMBIENT NOISE AT
PACIFIC WING AND ROTOR

Location: Pacific Wing and Rotor Temperature: 65 F

Date: February 1, 1984 Relative Humidity: 45%
Helicopter Model: Robinson 22 Wind Speed: 1 - 3 knots

Ambient Description	Measurement Duration (seconds)	Leq	SEL	Lmax
Ambient without helo or fixed-wing.	21	58.3	71.5	61.6
Same as above.	36	57.6	73.2	65.6
Same as above.	26	57.7	71.8	60.2
Ambient with small GA place taking off.	34	65.1	80.4	72.0
Helo flyover, 1500 ft.	63	63.6	81.6	68.9
Helo Looped 500 ft. by nearby mike.	43	62.6	78.9	70.1

All values were recorded using A-frequency weighting and plan response time averaging.

4.3 ACTUAL IN-SERVICE HELICOPTER OPERATIONS

Noise levels from several actual in-service helicopter operations were measured at nine sites in the Long Beach and Irvine, California area. Three of the sites were located at the helipads used in the standardized maneuver noise tests. At these three sites, noise monitoring equipment was kept in place after the test maneuvers were completed so that noise level data could be obtained for actual in-service helicopter operations in the vicinity of these helipads. The other six monitoring sites were at locations along commonly used helicopter approach and departure routes in the vicinity of the Long Beach Airport in Long Beach, and John Wayne Airport and the Marine Helicopter Training Base in Irvine, California. Figure 4.14 shows the locations of noise monitoring sites 1-6 in the vicinity of the Long Beach Airport. Figure 4.15 shows the locations of noise monitoring sites 7-9 in the vicinity of John Wayne Airport and the Marine Helicopter Training Base. Table 4.10 presents the noise data obtained from all of the in-service noise monitoring sites.

Most of the helicopters monitored in the vicinity of the Long Beach Airport were flying at an altitude of approximately 500 feet. Helicopters monitored in the vicinity of John Wayne Airport flew at altitudes between 1000 and 1500 feet. Helicopters monitored at the Marine Helicopter Training Base were at altitudes of approximately 250 feet. Table 4.11 shows summary statistics of the range of Leq, SEL, and Lmax levels measured by altitude.

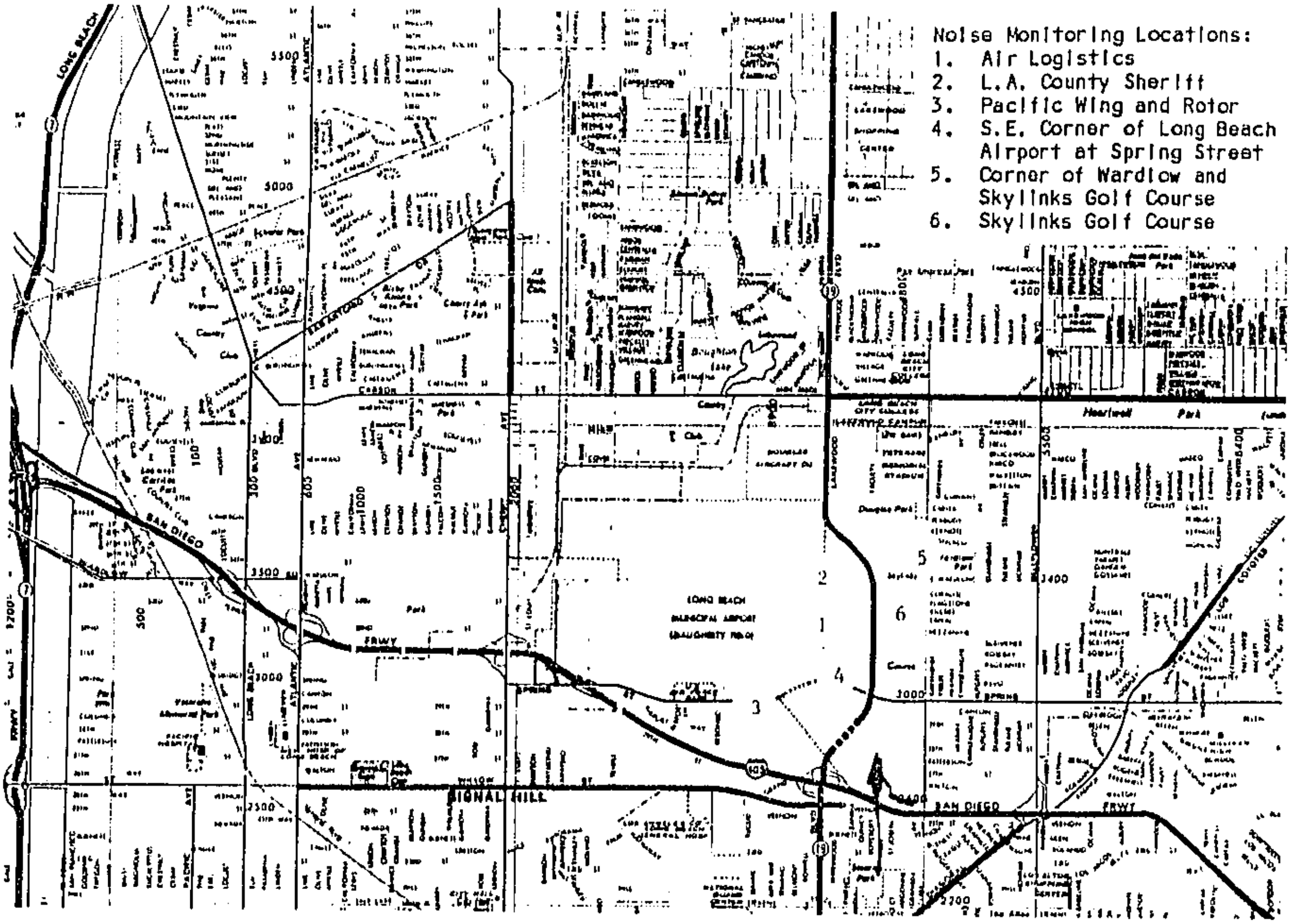


Figure 4.14 Locations of Monitoring Sites of Helicopter Flyovers in Vicinity of Long Beach Airport

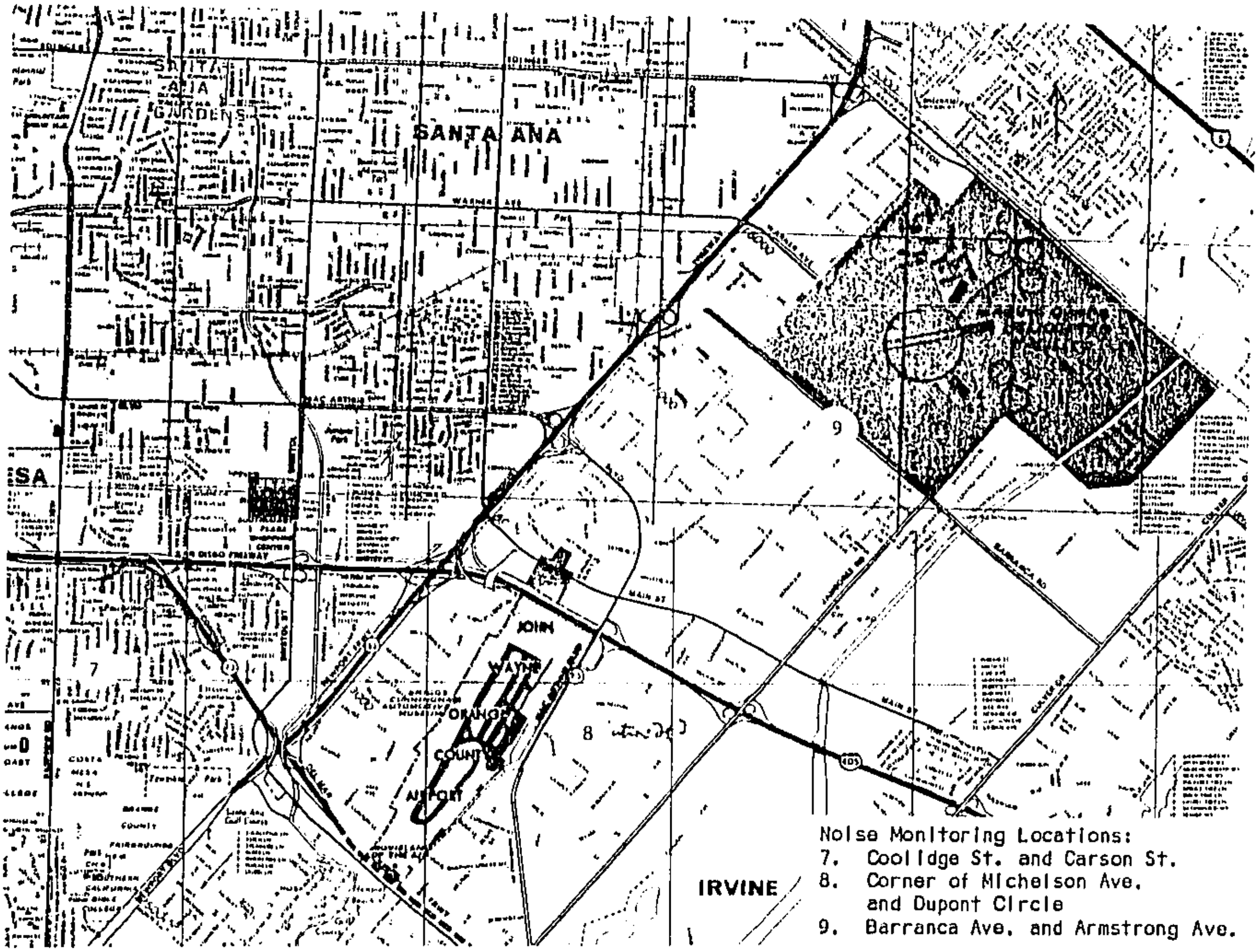


Figure 4.15 Locations of Noise Monitoring Stations at John Wayne Airport and Marine Helicopter Training Base

TABLE 4.10 NOISE DATA FOR ACTUAL IN-SERVICE HELICOPTER OPERATION IN THE VICINITY OF LONG BEACH

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Helicopter flyover.	1 (Station 3)	500	[1]	[1]	[1]	62
Helicopter flyover.	1 (Station 3)	500	[1]	[1]	[1]	62
Hughes 300B approach overhead and looped behind Station 1.	1 (Station 1)	500	19	65.3	78.1	68.4
Same as above.	1 (Station 2)	500	19	61.7	74.3	64.1
Same as above.	1 (Station 3)	500	[1]	[1]	[1]	62
Hughes 300B approach overhead and looped behind Station 1.	1 (Station 1)	500	29	65.5	80.1	70.5
Same as above.	1 (Station 2)	500	29	62.2	77.1	67.3
Same as above.	1 (Station 3)	500	[1]	[1]	[1]	62
Hughes 300B approach overhead and looped behind Station 1.	1 (Station 1)	500	24	65.3	79.1	70.2
Same as above.	1 (Station 2)	500	24	64.2	77.8	67.4
Same as above.	1 (Station 3)	500	[1]	[1]	[1]	64
Hughes 300B approach overhead and looped behind Station 1.	1 (Station 1)	500	38	65.8	81.4	69.6
Same as above.	1 (Station 2)	500	38	65.3	80.9	69.8

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figures 4.14 and 4.15 for station locations.
[1] Noise levels measured with CNA which is not capable of recording measurement duration, Leq, and SEL for single-events.

(continued next page)

TABLE 4.10 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Same as above.	1 (Station 3)	500	[1]	[1]	[1]	64
Hughes 300B approach overhead and looped behind Station 1.	1 (Station 3)	500	[1]	[1]	[1]	60
Helo looped around Station 3 and flew parallel to measurement array.	2 (Station 1)	500	70	63.9	82.4	69.6
Same as above.	2 (Station 2)	500	24	68.0	81.8	70.0
Same as above.	2 (Station 3)	500	[1]	[1]	[1]	67
Helo looped 1000' in front of Station 1.	2 (Station 2)	500	20	68.3	81.3	70.6
Same as above.	2 (Station 3)	500	[1]	[1]	[1]	72
Helo over golf course, landed at Air Logistics.	2 (Station 2)	500	13	68.9	81.0	72.5
Helo over golf course, landed at Air Logistics.	2 (Station 1)	500	26	58.2	72.3	63.4
Same as above.	2 (Station 2)	500	27	63.8	78.1	68.0
Helo looped over Station 1.	2 (Station 1)	500	63	64.7	82.7	69.3
Same as above.	2 (Station 2)	500	59	66.2	83.9	71.3

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figures 4.14 and 4.15 for station locations.
[1] Noise levels measured with CNA which is not capable of recording measurement duration, Leq, and SEL for single-events.

(continued next page)

TABLE 4.10 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Same as above.	2 (Station 3)	500	[1]	[1]	[1]	75
Helicopter flyover.	2 (Station 3)	500	[1]	[1]	[1]	71
Helicopter flyover.	2 (Station 3)	500	[1]	[1]	[1]	66
Flyover east to west.	3	500	36	71.6	86.7	75.4
Two helos circling.	3	500	92	69.8	89.4	75.2
Helicopter flyover.	3	500	72	71.3	89.9	78.1
Helo turned at tower.	3	350	60	68.5	87.5	73.5
Helo flyover north to south.	3	350	68	68.4	86.7	74.1
Helo from north, then circled tower.	3	350	22	70.6	84.0	73.9
Helo north, looped over tower, 2nd helo followed, twin engine plane took off.	3	500	92	71.1	90.7	75.7
Helo looped tower.	3	500	34	68.9	84.1	74.9
Helo looped over site and landed.	4	500	50	69.1	86.1	77.3
Helo looped and landed directly over station.	4	150	58	81.3	98.9	91.0
Helo overhead at right angle to station.	5	500	22	71.2	84.6	76.4

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figures 4.14 and 4.15 for station locations.
[1] Noise levels measured with CNA which is not capable of recording measurement duration, Leq, and SEL for single-events.

(continued next page)

TABLE 4.10 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Halo directly overhead.	5	500	13	70.0	81.1	74.7
Halo looped overhead.	5	350	28	78.2	90.7	83.9
Halo turned behind site.	6	500	[1]	[1]	[1]	72
Halo turned over site.	6	500	[1]	[1]	[1]	73
Hughes 500-C turned behind site.	6	500	[1]	[1]	[1]	78
Halo turned over site.	6	500	[1]	[1]	[1]	75
Halo turned over site.	6	500	[1]	[1]	[1]	75
Medium halo approach at 10:00.	7	1000	33	65.9	81.1	71.4
Halo looped around site.	7	1000	65	64.1	82.1	68.1
Medium halo approach at 1:00.	7	1500	43	59.7	76.0	62.9
Halo passed from 10:00 to 3:00.	7	1500	35	62.0	77.4	61.1
Halo passed from 4:00 to 7:00.	7	1500	19	58.9	72.7	64.3
Halo approached at 8:00 circled behind station and departed at 1:00.	7	1200	33	61.3	76.5	68.0

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figures 4.14 and 4.15 for station locations.
[1] Noise levels measured with CNA which is not capable of recording measurement duration, Leq, and SEL for single-events.

(continued next page)

TABLE 4.10 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Helo looped at 4:00, two cars passed.	7	1500	131	64.2	85.4	71.2
Helo approached and looped.	8	1000	72	64.1	82.7	72.9
Single rotor helo circled station.	9	250	17	73.1	85.4	78.5
Single rotor helo circled station.	9	250	16	73.9	85.9	77.0
Tandem rotor helo circled station.	9	250	25	68.5	82.5	71.8
Single rotor helo circled station.	9	250	21	73.7	86.8	79.7
Single rotor helo circled station.	9	250	15	82.1	93.8	89.8
Helicopter flyover.	9	250	20	83.5	96.4	89.1
Helicopter flyover.	9	250	20	80.9	93.9	87.2

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figures 4.14 and 4.15 for station locations.
[1] Noise levels measured with CNA which is not capable of recording measurement duration, Leq, and SEL for single-events.

TABLE 4.11

RANGE OF LEQ, SEL AND LMAX, BY ALTITUDE

Estimated Altitude (in feet)	Leq (dB(A)) min max	SEL (dB(A)) min max	Lmax (dB(A)) min max
250-499	68.4-83.5	82.5-96.4	71.8-89.6
500-999	58.2-76.2	72.3-90.7	60.0-78.1
1000-1499	61.3-65.9	76.5-82.7	66.0-72.9
>1499	59.7-64.3	72.7-85.4	61.1-71.2

The difference in noise levels recorded is a function of both the size and type of helicopter as well as the slant distance from the microphone to the helicopter. Leq and SEL levels for actual in-service helicopter operations were measured for the duration of each event, which varied considerably. For example, a helicopter circling around a noise monitoring station has a larger single-event time duration than a helicopter takeoff or flyby.

CHAPTER 5

RESULTS OF THE HELICOPTER NOISE SURVEY IN SEATTLE, WASHINGTON

This chapter presents the results of the helicopter noise survey performed in Seattle, Washington. The chapter is divided into three sections. Section 5.1 presents a general overview of helicopter operations relative to land use patterns in Seattle. Section 5.2 presents noise measurement data and land use characteristics at four helipad test sites. Section 5.3 presents noise measurement data recorded from actual in-service helicopter operations in the Seattle Commercial Business District.

5.1 OVERVIEW OF HELICOPTER OPERATIONS PROCEDURES RELATIVE TO LAND USE PATTERNS AND NOISE

As helicopter traffic in urban areas increases, so does the concern that helicopter noise might adversely impact noise-sensitive land use areas, such as residential districts, schools, and parks. It is a result of this concern in Seattle that city planners, the FAA, heliport designers, and helicopter operators have initiated a coordinated effort to establish and implement several helicopter noise abatement procedures. These procedures include:

- Designating the areas above waterways, freeways, and railroad tracks as helicopter flight paths;

- Routing helicopters away from residential areas whenever possible;

- Limiting the number of helicopter flights during the nighttime hours of 10:00 p.m. to 7:00 a.m.

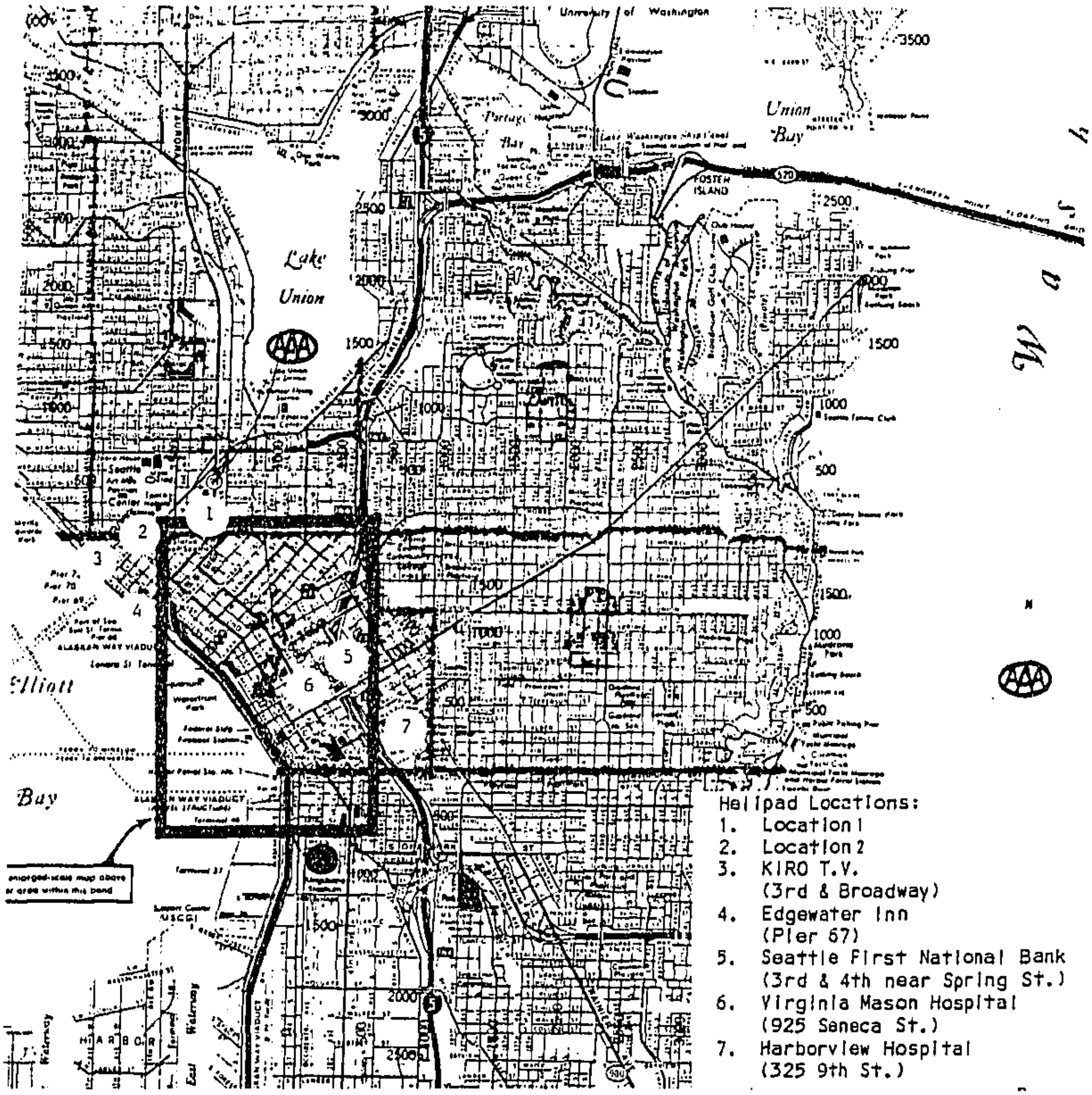
- Following industry-wide helicopter operational noise abatement procedures, such as those published by the Helicopter Association International ["Fly Neighborly Program", Helicopter Association International, February, 1982].

Without a thorough study of citizens' reactions to helicopter noise, it is difficult to judge the overall effectiveness of these procedures. However noise complaint estimates obtained from airport officials in Seattle seem to indicate that the procedures have helped to reduce the noise impact of helicopters.

For example, airport officials estimated that in 1983 helicopter-related noise complaints averaged no more than one per month. This number of complaints appears to be low in light of the volume of helicopter traffic.

According to operational data obtained from helicopter operators, and airport and city officials, there are currently fifteen permanent helipads located in the Seattle area. Figures 5.1 and 5.2 show the street map locations of these helipads in North and South Seattle, respectively. Test were performed at locations 1 and 2 in Figure 5.1 and locations 11 and 14 in Figure 5.2.

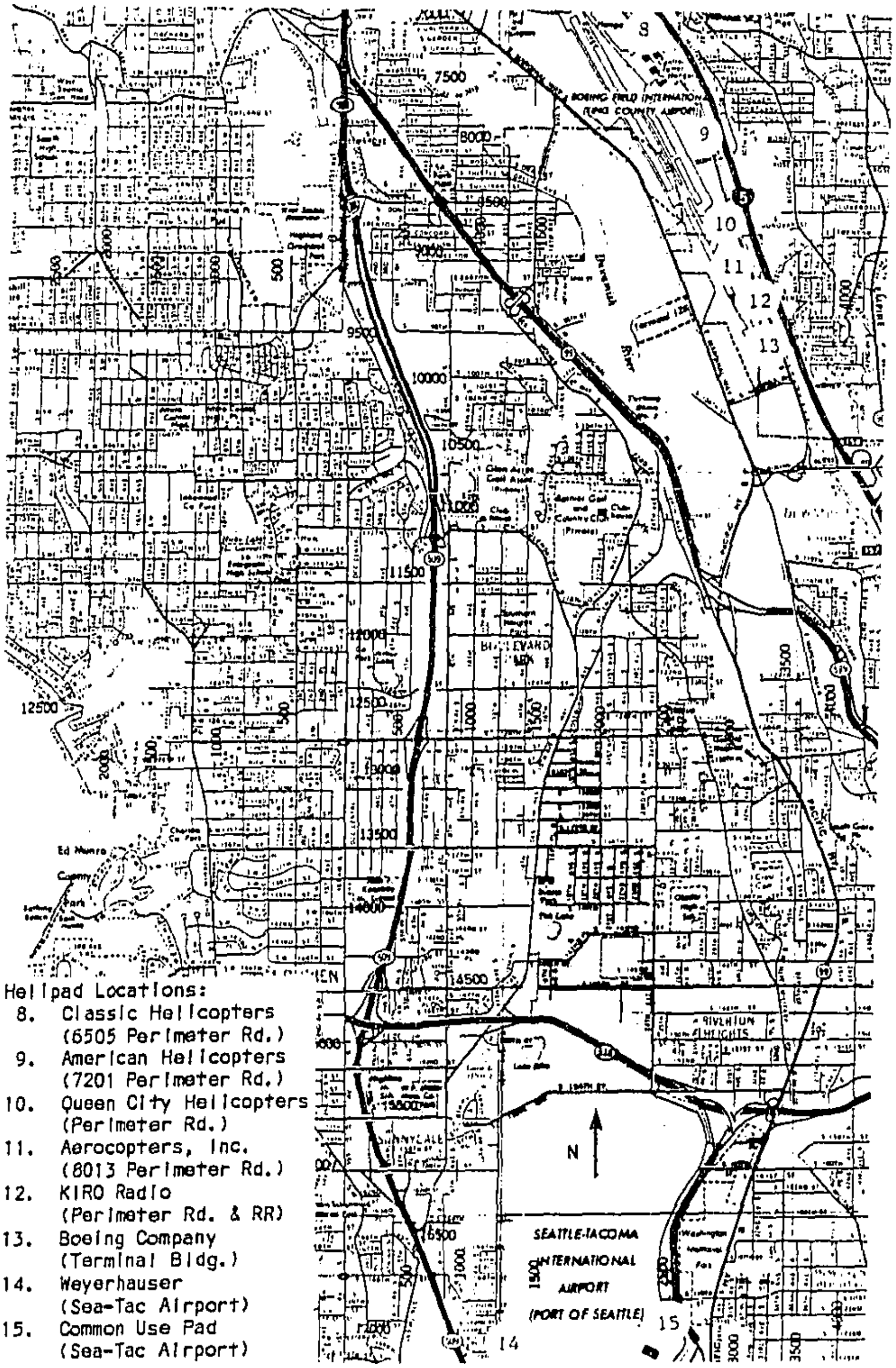
The helipads in Seattle are located in three principal areas: the Commercial Business District; Boeing Field International Airport; and Seattle-Tacoma International Airport. Figures 5.3 and 5.4 display the land use characteristics of North and South Seattle, respectively, in relation to the existing helipads and commonly used helicopter flight paths.



Helipad Locations:

1. Location 1
2. Location 2
3. KIRO T.V. (3rd & Broadway)
4. Edgewater Inn (Pier 67)
5. Seattle First National Bank (3rd & 4th near Spring St.)
6. Virginia Mason Hospital (925 Seneca St.)
7. Harborview Hospital (325 9th St.)

Figure 5.1 Location of Helipads in North Seattle



Helipad Locations:

8. Classic Helicopters (6505 Perimeter Rd.)
9. American Helicopters (7201 Perimeter Rd.)
10. Queen City Helicopters (Perimeter Rd.)
11. Aerocopters, Inc. (8013 Perimeter Rd.)
12. KIRO Radio (Perimeter Rd. & RR)
13. Boeing Company (Terminal Bldg.)
14. Weyerhauser (Sea-Tac Airport)
15. Common Use Pad (Sea-Tac Airport)

Figure 5.2 Location of Helipads in South Seattle

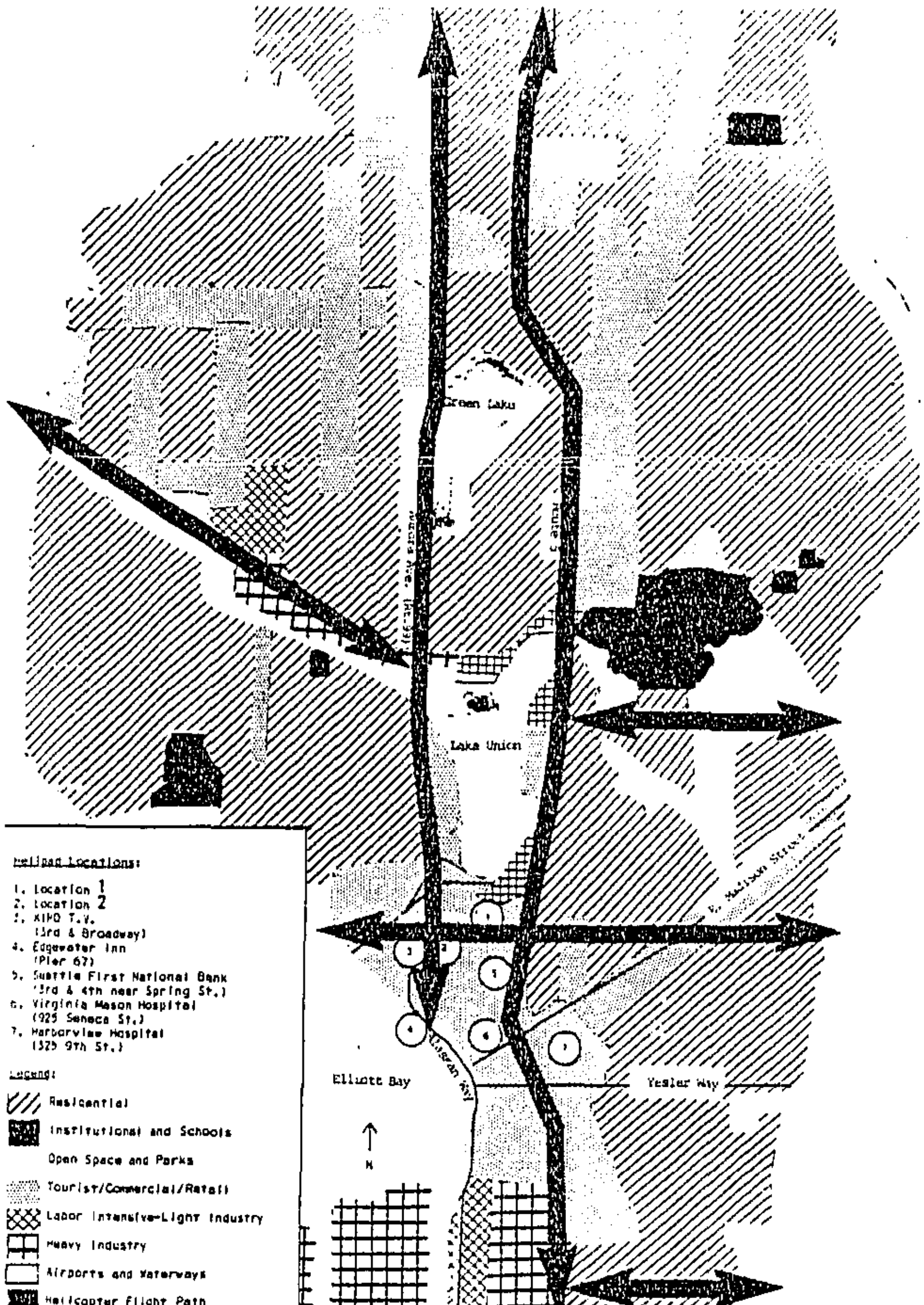


Figure 5.3 Land Use Characteristics of North Seattle in Relation to Existing Helipads and Helicopter Flight Paths

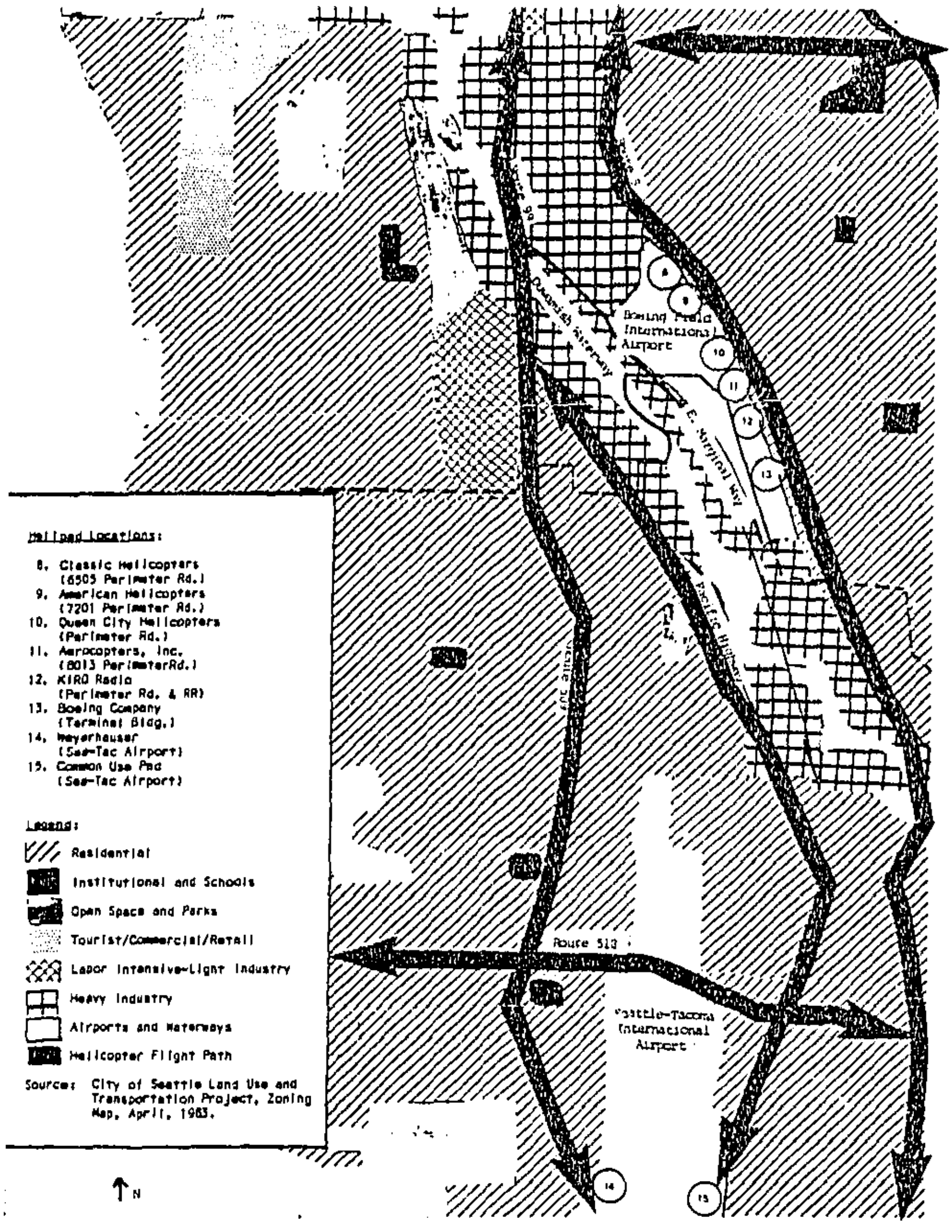


Figure 5.4 Land Use Characteristics of South Seattle in Relation to Existing Helipads and Helicopter Flight Paths

In the downtown area of Seattle there are helipads at three television stations, a hotel, a bank and two hospitals (locations 1 through 7 in Figure 5.3). The helipads at the three T.V. stations (KING T.V., KOMO T.V., and KIRO T.V.) are rooftop helipads. Helicopters that operate from these helipads are used to cover news stories and to report traffic conditions. The local police department also uses these helipads occasionally for emergency search and rescue operations. Because of the unpredictable nature of news stories and emergency situations, the daily number of helicopter operations originating from these helipads varies considerably, but is generally not more than about eight per day at each helipad.

The hotel helipad is privately owned by the Edgewater Inn and is used primarily by hotel customers who charter private helicopter companies to transport them between the Inn and either Boeing Field International or Seattle-Tacoma International Airport. The number of operations at this helipad usually averages one per day during the winter months and increases to two or three per day during the summer months.

The bank helipad is privately owned by Seattle First National Bank and is mainly used for executive personnel transport. Helicopter operations to and from this helipad are fairly infrequent. The helipad at Harborview Hospital and the one at Virginia Mason Hospital are served mainly by military helicopters engaged in emergency operations.

Land use in the downtown area consists mainly of commercial and retail establishments with some small pockets of light manufacturing industries. Elliott Bay and the Duwamish Waterway border the downtown area to the west. Detached single family homes and some medium density residential dwellings border the downtown area to the north and east. A heavy industrial zone lies to the south.

Helicopters operating in the downtown area usually approach and depart from the west from Elliott Bay, from the east along Route 520 or Interstate 90, and from the north and south along Interstate 5, Route 99, or the Duwamish Waterway.

Boeing Field International Airport, located in the southern portion of Seattle, has the highest concentration of helipads in the city. There are currently eight private helicopter companies operating at the airport (locations 8 through 13 in Figure 5.4). These helicopter companies provide a wide range of services such as maintenance and repair, personnel transport, public services, FAR 135 charter services, and heavy lifting for constructions projects. Each of these helicopter companies averages between two to five operations a day during the winter months and between five and ten operations a day during the summer months. A Boeing Company corporate helipad is also located at the airport and is used to transport company executives to corporate facilities in Renton, Washington. This helipad accounts for approximately two operations a day.

Land use directly to the northwest, west, and south of Boeing Field International Airport is predominantly heavy industry. Land use further west and to the northeast is primarily detached single family residences, with several large parks and schools. Interstate 5 and a major railroad run north and south along the eastern perimeter of the airport.

Helicopters that operate from the helipads at Boeing Field International Airport normally fly along Interstate 5, Route 99, or the railroad tracks when approaching or departing to the north or south. To fly east or west helicopters cannot avoid passing over residential areas, because of the absence of waterways or major roads. This is where most helicopter related noise complaints near the airport originate.

Seattle-Tacoma International Airport is located south of Seattle and is the site of a private helipad and maintenance facility for Weyerhauser, Inc. and an airport-owned common use helipad. Helicopters at Weyerhauser include executive personnel transport and some FAR 135 charter services, but are primarily used for forest-related work outside of the immediate Seattle area. There are between five to ten operations a day originating from Weyerhauser's facilities. The common use helipad, which is also located at Seattle-Tacoma International Airport, is owned by the airport and accepts transient helicopter operations.

Seattle-Tacoma International Airport is situated in a predominantly residential area. It is surrounded on all sides by detached single family and medium density housing. Puget Sound lies approximately five miles to the west.

Officials at the airport have requested that helicopters from the northwest and southwest fly over Puget Sound and approach directly from the west. This approach route is designed to minimize the amount of helicopter noise exposure on large residential areas lying to the north and south. However, as a result of directing helicopter traffic away from these large residential areas, helicopter traffic over a smaller residential area to the west between Puget Sound and the airport is intensified. Most of the helicopter-related noise complaints received at the airport originate in this area to the west.

Helicopters operating to or from the north and south are requested to use Interstate 5, Route 99 or Route 509. Helicopters operating to or from the east are asked to use Route 518. In addition to the specified flight routes, all air traffic is requested to avoid approaching the airport from or departing to the north between the hours of 10:00 p.m. to 7:00 a.m.

5.2 STANDARDIZED MANEUVER TESTS

Two helicopter models were tested: a Bell 206B Jetranger III and a Hughes 500D. Manufacturers' specifications for these helicopters are shown in Appendix B. Noise monitoring stations were set up to measure noise levels from standardized helicopter test maneuvers at four helipads in the Seattle area. Two of the helipad test sites chosen were Aerocopters, Inc. and Weyerhauser, Inc., located outside the Central Business District (CBD). The two other helipad test sites chosen were located within the Seattle CBD. Company officials operating these two helipads requested that their corporate names not be used in this report. Therefore, these two helipads will be referred to as Seattle CBD Sites 1 and 2. Sections 5.2.1 through 5.2.4 describe the locations of the noise monitoring stations, the helicopter test maneuvers performed, and the noise measurement data obtained at each of the four helipad test sites.

5.2.1 Aerocopters, Inc.

Aerocopters, Inc. is a privately owned helicopter company based at Boeing Field International Airport. This is location 11 in Figures 5.2 and 5.4. The airport is situated in an industrial zone with heavy industry to the northwest, west, and south. There is a residential neighborhood approximately a fourth of a mile to the east of the helipad.

Three noise monitoring stations were set up in an array extending 100 feet, 280 feet, and 480 feet south of the helipad. A site schematic showing the locations of the noise monitoring stations as well as the flight path used by the test helicopter on its approach and takeoff are shown in Figure 5.5. All three noise monitoring stations were located on an asphalt surface within the boundaries of Boeing Field International Airport, and were approximately 35 feet to the east of the airport taxi way.

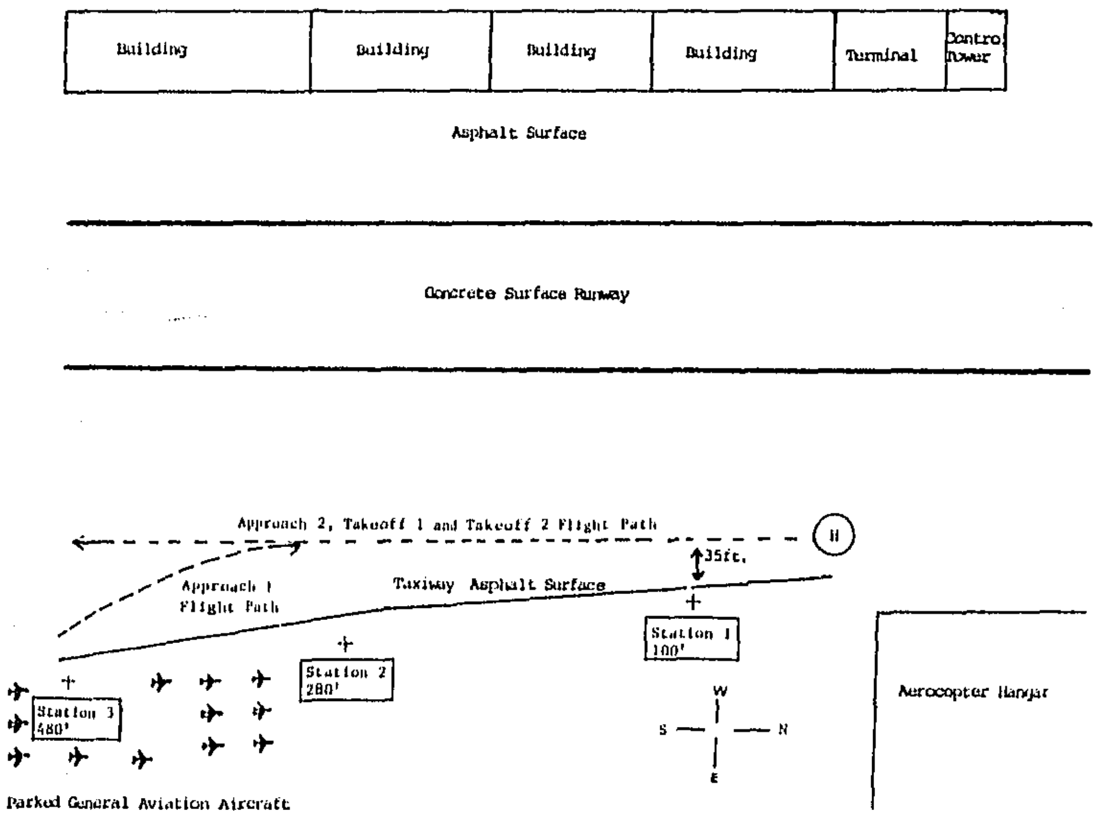


Figure 5.5 Site Schematic for Aerocopters, Inc. Test Site

Regulations at Boeing Field International Airport prohibited setting up stations on the edge of the taxi way. As a result, it was necessary to extend the measurement array into the General Aviation parking area. The distances of the stations from the helipad were adjusted to avoid setting up any station directly next to a parked general aviation aircraft. The helipad is on airport property; consequently there were several aircraft operations taking place during noise monitoring of the test maneuvers. Most of the operations were general aviation aircraft. In addition, several trains passed by during the test maneuvers from railroad tracks along the eastern perimeter of Boeing Field International Airport. Noise from general aviation aircraft operations and trains contributed to a high background ambient noise level during the measurement periods.

The helicopter pilot at Aerocopters, Inc. using a Bell 206B Jetranger III, performed the following maneuvers in the order listed.

1. 100% flat pitch, idle, West;
2. Hover, west;
3. Takeoff, to South;
4. Approach, from North;
5. Takeoff, to South;
6. Approach, from North.

Table 5.1 shows the noise levels recorded from the test maneuvers at the three measurement stations. Takeoffs and approaches were performed approximately 50 feet to the west of the measurement array. On the first approach the helicopter passed directly over Station 3 approximately 50 feet to the west of Stations 1 and 2. This may explain why the Lmax value recorded for Station 3 for the first approach is higher than that recorded at Station 2. On the second approach the helicopter maintained a level altitude 30 to 40 feet parallel and to the west of the noise measurement

TABLE 5.1 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT AEROCOPTERS, INC.

Location: Aerocopter, Inc.
Date: March 28, 1984
Time: 2:30 p.m.
Helicopter Model: Bell 206B Jetranger III

Temperature: 53 F
Dew Point: 38
Wind Speed: 5 - 7 knots from N.E.

Station	Dist. From Pad (ft.)	Idle (West)				Hover (West)				Takeoff 1[1][+]				Approach 1[2][+]				Takeoff 2[1][+]			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	100	31	88.8	103.7	100.3	36	88.5	103.8	101.2	17	91.1	103.3	99.7	32	84.8	99.9	93.1	14	89.3	100.7	96.9
2	200	32	80.2	95.2	93.2	37	78.9	94.6	92.9	17	85.1	97.4	90.1	35	82.7	97.8	89.8	13	84.3	95.5	88.8
3	400				77				*				86				91				84

Station	Dist. From Pad (ft.)	Approach 2[+]			
		Time (sec.)	Leq	SEL	Lmax
1	100	38	83.3	98.8	90.0
2	200	40	81.7	97.7	90.1
3	400				*

All noise data recorded with A-frequency weighting and slow response time averaging.

[+] = Noise data not directly comparable with corresponding data in other tests. See text.

* = Ambient background noise too high to detect maneuver.

[1] = Helicopter at 50' altitude 40' west of Station 2 (visual judgement).

[2] = Helicopter at 40' altitude 40' west of Station 2 (visual judgement).

array. This accounts for similar noise levels being recorded at all three stations. Because the approach and takeoff maneuvers were not performed over the noise measurement array, the data are not directly comparable to other approach and takeoff data.

The SPL charts from Stations 2 and 3 for each maneuver are shown in Figures 5.6 and 5.7, respectively. A chart is not available for Station 1 because of walkie-talkie signal interference with the GLR motor. (Subsequent bench tests of the sound level meters and a review of the measurement data indicates, however, that the walkie-talkie does not affect the sound level meters.)

Table 5.2 shows ambient noise data recorded at Station 3 for two, half-hour and one, one-hour consecutive sample periods. Station 3 was located adjacent to the airport taxiway; consequently, several general aviation and jet aircraft passed near the station on their takeoffs and landings which accounts for the high Leq levels recorded, ranging from 73 dB(A) to 84 dB(A). Due to the high frequency of aircraft operations during all of the sample periods and a Lear jet taxiing within 25 feet of the microphone during two of the sample periods, it is not possible to draw any firm conclusions on the contribution of the helicopter test maneuvers to existing ambient background noise levels.

Table 5.3 presents maximum sound levels (Lmax) recorded at Station 3 for non-helicopter noise events that occurred during the ambient noise sample periods (primarily GA and jet operations) and the Lmax levels recorded from the helicopter test maneuvers that could be detected. The highest Lmax level measured was from a Lear jet warmup within 25 feet of the microphone that registered 114 dB(A). Two Boeing 757 jet takeoffs 200 feet to the west of the measurement array registered maximum sound levels of 90 dB(A). By comparison, the Bell 206B Jetranger III test helicopter registered Lmax values of 77 dB(A) for the idle facing west, 84 dB(A) and 86 dB(A) on two takeoffs, and 91 dB(A) for the first approach.

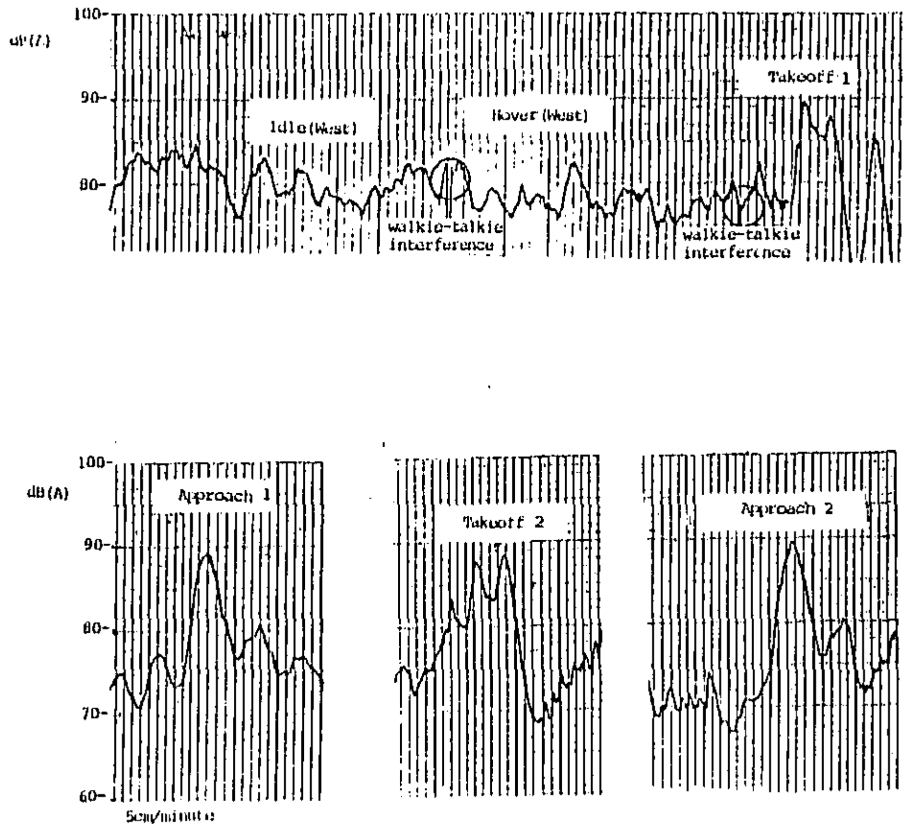


Figure 5.6 GLR Output for Aerocopters, Inc. Test - Station 2

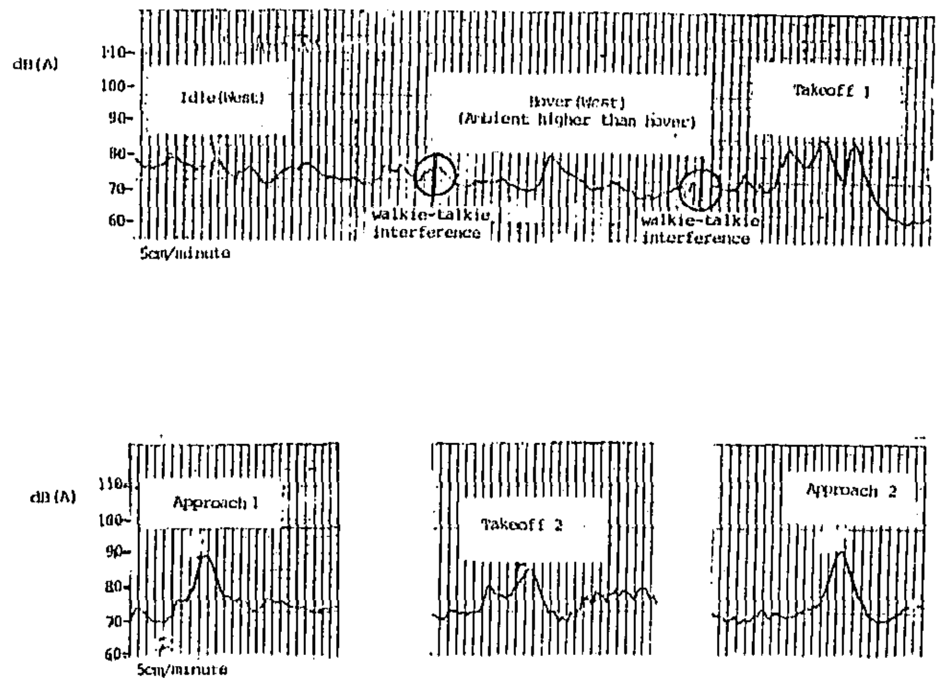


Figure 5.7 GLR Output for Aerocopters, Inc. Test - Station 3

TABLE 5.2 AMBIENT NOISE LEVELS AT AEROCOPTER, INC.

Location: Aerocopter, Inc. (Station 3)
Date: March 26, 1984
Time: 12:30 p.m.-2:45 p.m.
Helicopter Model: Bell 206B Jet ranger III

Temperature: 53 F
Dew Point: 38
Wind Speed: 5 - 7 knots from NE

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient without helicopter test maneuvers	12:36-1:06	1/2 Hour	114(1)	88	82	75	60	58	55	54	77	1 Jet t.o., 2 com. jet flyover, 1 GA land, 1 GA t.o., 1 Lear jet warmup.
Ambient without helicopter test maneuvers	1:08-1:38	1/2 Hour	88(2)	86	83	76	68	64	63	62	73	3 jet fly by, train passed by, 1 jet warm-up, 1 GA warm-up, 757 t.o., 2 GA t.o.
Ambient with helicopter test maneuvers	1:45-2:45	1 Hour	—	95	87	78	73	65	62	60	84	Commercial jet t.o., 2 jet fly by, 1 jet landing, 1 GA t.o., Lear jet warm-up 1 ft. from mic., GA warm-up.

All noise data were recorded with A-frequency weighting and slow response time averaging.

— = No values obtained due to equipment malfunction.
(1) Lmax from Lear jet warmup 25 feet from microphone.
(2) Lmax from jet takeoff.

TABLE 5.3 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3 AEROCOPTERS INC.

Location: Aerocopter, Inc. (Station 3)
Date: March 28, 1984
Time: 12:38 p.m. - 2:45 p.m.

Temperature: 53 F
Dew Point: 38
Wind Speed: 5 - 7 knots from NE

General Aviation operations:	Lmax
General Aviation Warmup	82
General Aviation Takeoff	78
General Aviation Takeoff	83
General Aviation Takeoff	77
General Aviation Takeoff	80
General Aviation Landing	74
Jet Operations:	
Jet Takeoff	80
Boeing 757 Jet Takeoff	90
Boeing 757 Jet Takeoff	90
Jet Takeoff	88
Jet Landing	81
Jet Flyover	78
Jet Flyover	78
Jet Flyover	83
Jet Flyover	85
Jet Flyover	82
Jet Flyover	81
Jet (taxi)	91
Lear jet warmup (25 ft. from microphone.)	114
Helicopter Test Maneuvers:	
Idle(West)	77
Takeoff 1	80
Takeoff 2	84
Approach 1	91

All noise data were recorded with A-frequency weighting and slow response time averaging.

5.2.2 Seattle CBD Site 1

The helipad at the CBD site 1 is located approximately 50 feet above ground on the rooftop of a building in the Seattle Commercial Business District. This is location 1 in Figures 5.1 and 5.3. Land use in the downtown area around the helipad is comprised primarily of low-rise commercial and retail businesses. There are several high-rise apartment and office buildings located ten blocks to the west of the helipad. Elliott Bay and the waterfront tourist area are approximately half a mile to the west. The Seattle Skydome and Exhibit Center are located eight blocks north of the helipad. Three noise monitoring stations were set up in an array extending north from the helipad. Figure 5.8 shows a site schematic of the three noise monitoring station locations as well as the flight paths used on the approach and takeoff maneuvers. Station 1 was located on the gravel roof of the helipad building 110 feet from the helipad. Station 2 was located 215 feet from the helipad on a concrete sidewalk adjacent to a four-lane street. Station 3 was located 665 feet from the helipad on a grass surface near a street corner. Because the helipad is located in the downtown area of Seattle, relatively heavy automobile traffic was present on all streets in the vicinity during the test maneuvers.

The helicopter pilot at CBD Site 1, using a Hughes 500D helicopter performed the following maneuvers in the order listed.

1. Warm-up;
2. 100% flat pitch, idle, South;
3. Hover, South;
4. Hover, West;
5. Hover, East;
6. 100% flat pitch, idle, East;
7. Takeoff, to North;
8. Approach, from South;
9. Takeoff, to North.

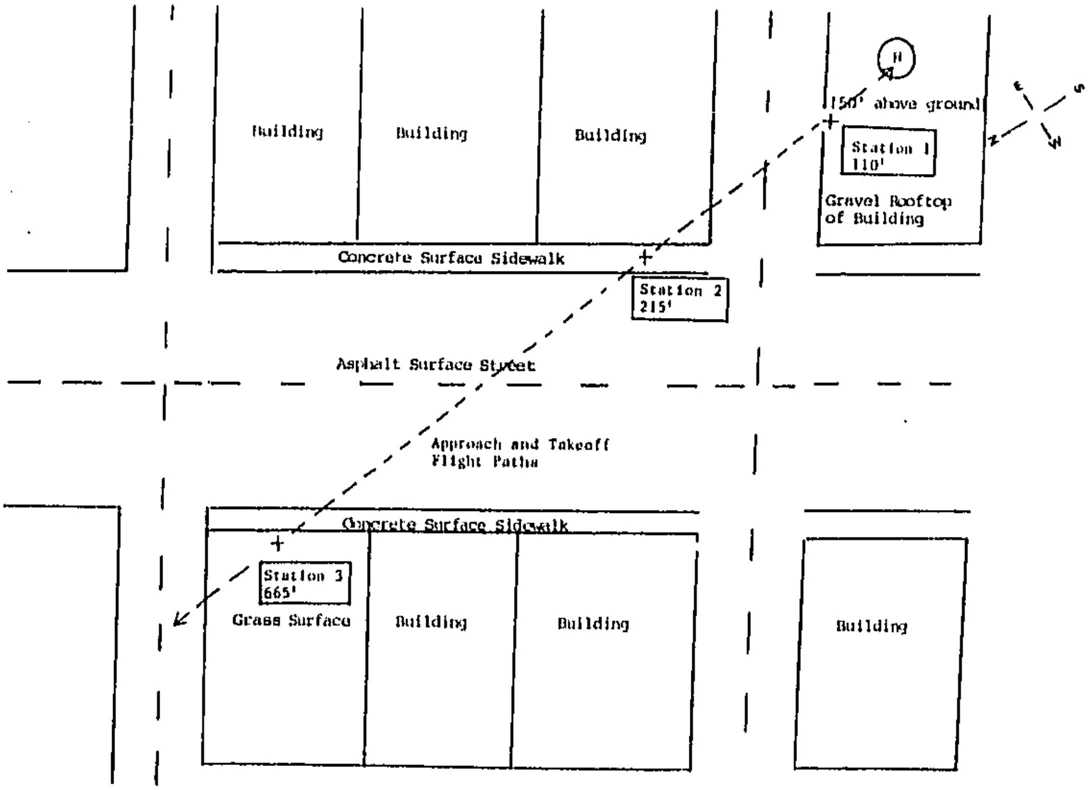


Figure 5.8 Site Schematic for Seattle CBD Site 1 Test Site

Table 5.4 shows the noise levels recorded during the test maneuvers at the three measurement stations. The takeoffs and the approach were executed directly over the noise measurement array. The second takeoff was executed to the west perpendicular to the noise measurement array. (For this reason, the takeoff data for this maneuver is not directly comparable to other takeoff data.) Stations 2 and 3 were unable to detect any of the idle or hover maneuvers because of high background ambient noise from street traffic. The graphic charts of the test maneuvers for Stations 1, 2, and 3 are shown in Figures 5.9, 5.10, and 5.11, respectively.

Table 5.5 shows noise data obtained from a one-hour ambient noise sample and a half-hour ambient noise sample measured at Station 3. The one-hour ambient noise sample includes the helicopter test maneuvers which lasted for approximately 15 minutes and moderate automobile traffic on an adjacent street. The half-hour ambient noise sample measured existing background ambient noise without the helicopter test maneuvers. There is only a one dB(A) difference in the Leq and L50 (median) levels between samples. This seems to indicate that there was no substantial contribution of the noise from the helicopter test maneuvers to existing background ambient noise levels.

Table 5.6 presents maximum sound levels recorded at Station 3 from non-helicopter noise sources and from helicopter test maneuvers that occurred during the ambient noise measurement periods. Maximum sound levels from the helicopter takeoff and approach maneuvers were louder than maximum sound levels measured for general street traffic, except for isolated events such as a car horn. The helicopter's idle and hover maneuvers, however, could not be detected above existing non-helicopter noise sources.

TABLE 5.4 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT SEATTLE CBD SITE 1

Location: Seattle CBD Site 1
Date: March 27, 1984
Time: 1:00 p.m.
Helicopter Model: Hughes 500D

Temperature: 55 F
Dew Point: 40
Wind Speed: 1 - 3 knots from South

Station	Dist. From Pad (ft.)	Idle(South) Time (sec.)	Idle(South) Leq	Idle(South) SEL	Idle(South) Lmax	Hover(South) Time (sec.)	Hover(South) Leq	Hover(South) SEL	Hover(South) Lmax	Hover(West) Time (sec.)	Hover(West) Leq	Hover(West) SEL	Hover(West) Lmax	Hover(East) Time (sec.)	Hover(East) Leq	Hover(East) SEL	Hover(East) Lmax	Idle(East) Time (sec.)	Idle(East) Leq	Idle(East) SEL	Idle(East) Lmax
1	110	37	85.3	100.9	89.4	35	88.8	104.2	97.9	41	87.2	103.3	90.9	36	90.1	105.5	91.6	38	86.3	102.1	88.1
2	215		*	*	*		*	*	*		*	*	*		*	*	*		*	*	*
3	665				*				*				*				*				*

Station	Dist. From Pad (ft.)	Takeoff 1[1] Time (sec.)	Takeoff 1[1] Leq	Takeoff 1[1] SEL	Takeoff 1[1] Lmax	Approach[1] Time (sec.)	Approach[1] Leq	Approach[1] SEL	Approach[1] Lmax	Takeoff 2[+] Time (sec.)	Takeoff 2[+] Leq	Takeoff 2[+] SEL	Takeoff 2[+] Lmax
1	110	19	90.4	103.2	100.4	39	90.9	108.8	97.7	–	–	–	–
2	215	16	84.4	96.4	90.1	37	85.4	101.1	92.4	19	84.8	97.5	91.7
3	665				65				64				65

All noise data were recorded with A-frequency weighting and slow response time averaging.

– = Station 1 dismantled before the second takeoff.
* = Background noise too high to detect maneuver.

[1]=Helo estimated at 70' altitude directly over Station 2 (photo scaling).

[+]=Noise data not directly comparable with corresponding data in other tests. See text.

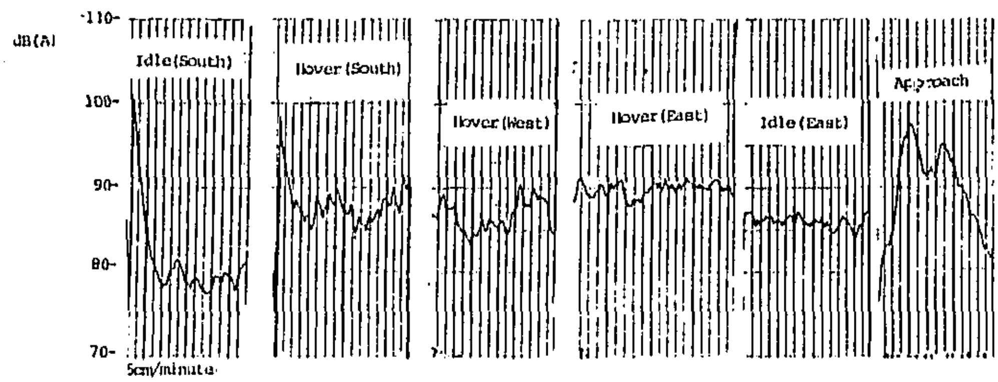


Figure 5.9 GLR Output for Seattle CBD Site 1 - Station 1

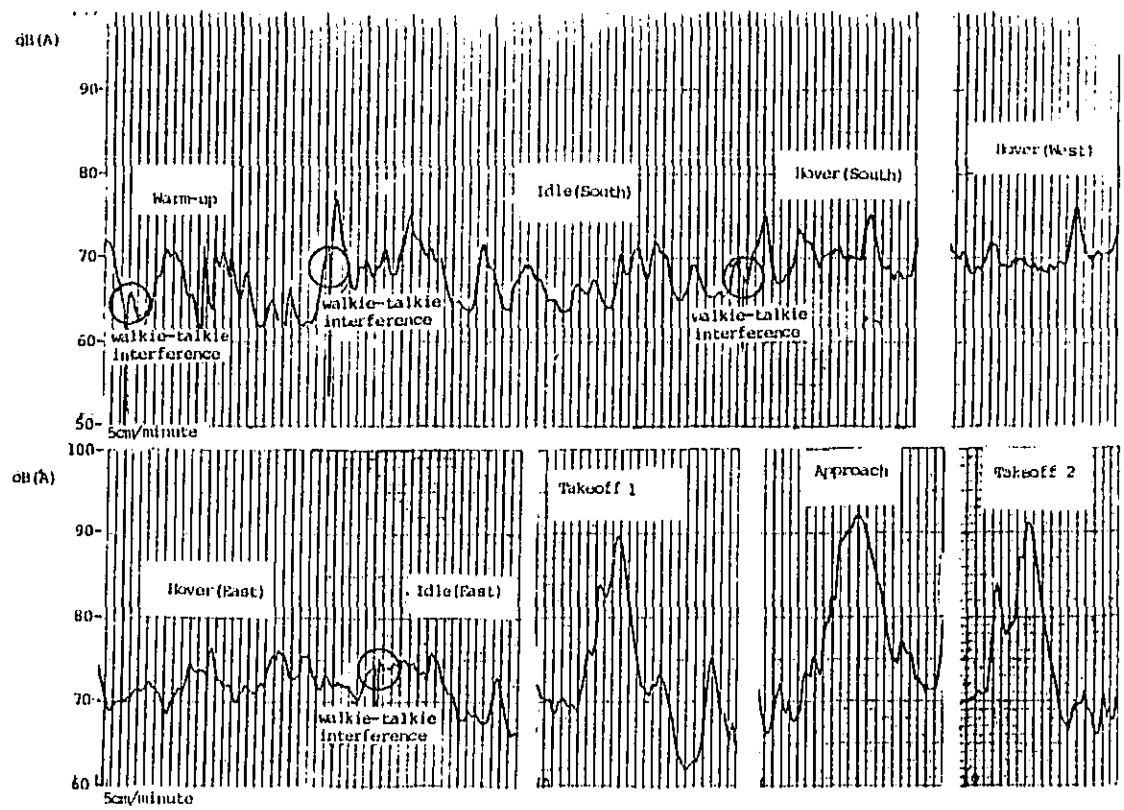


Figure 5.10 GLR Output for Seattle CBD Site 1 Test - Station 2

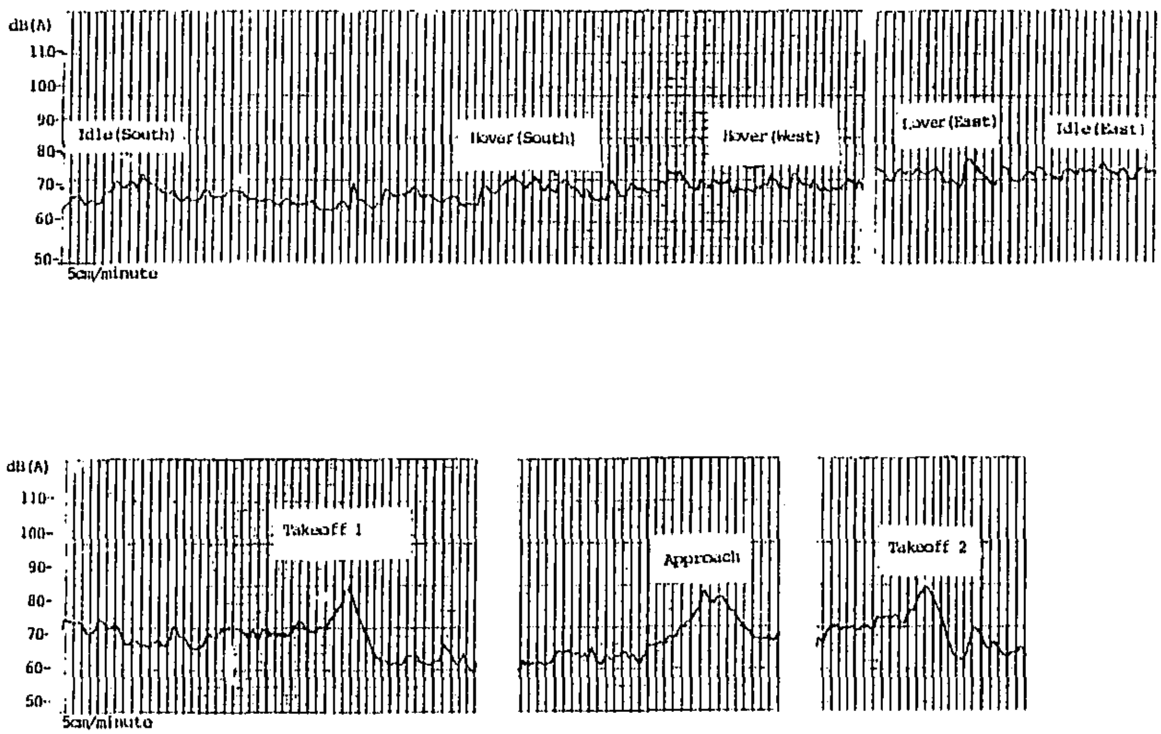


Figure 5.11 GLR Output for Seattle CBD Site 1 Test - Station 3

TABLE 5.5 AMBIENT NOISE LEVELS AT SEATTLE CBD SITE 1

Location: Seattle CBD Site 1 (Station 3)
Date: March 27, 1984
Time: 12:45 p.m-2:30 p.m.
Helicopter Model: Hughes 500D

Temperature: 55 F
Dew Point: 40
Wind Speed: 1 - 3 knots from South

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient with helicopter test maneuvers.	12:45-1:45	1 Hour	85(1)	84	78	73	65	60	57	55	68	Includes moderate car traffic, police car with siren, bus, car horn.
Ambient without helicopter test maneuvers.	2:00-3:00	1/2 Hour	87(2)	86	77	70	64	60	57	55	68	Includes moderate automobile traffic.

All data were recorded with A-frequency weighting and slow response time averaging.

(1) = Lmax recorded from test helicopter takeoff.
(2) = Lmax recorded from 18-wheel semi truck break squeal.

TABLE 5.8 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT SEATTLE CBD SITE 1 STATION 3

Location: Seattle CBD Site 1 (Station 3)
Date: March 27, 1984

Temperature: 55 F
Dew Point: 40
Wind Speed: 1 – 3 knots from South

GA Flyovers:	
GA Flyover	73
Street Traffic:	
No Automobile Traffic	58
Police Car With Siren	73
Car Horn	83
Car	82
Bus	78
Truck	78
Cement Truck	77
Truck	85
Dump Truck	77
Semi-truck	77
Semi-truck	78
Semi-truck accelerating	87
Brake squeal	87
Helicopter Test Maneuvers:	
Takeoff 1	85
Takeoff 2	86
Approach	84

All noise data were recorded with A-frequency weighting and slow response time averaging.

5.2.3 Weyerhauser, Inc.

Weyerhauser, Inc. has a corporate helipad on the western perimeter of Seattle-Tacoma International Airport. This is location 15 in Figures 5.2 and 5.4. Land use in the vicinity of the helipad is predominatly detached single-family housing. There is a large park located a half mile directly to the west of the helipad.

Three noise monitoring stations were set up in an array extending 150 feet, 300 feet, and 452 feet south from the helipad. Figure 5.12 shows a site schematic of the noise monitoring locations and surrounding area as well as the flight paths used for the takeoff and approach maneuvers. The three noise monitoring stations and the helipad were located on a grass surface approximately 800 feet to the west of the airport runway.

The helicopter pilot at the Weyerhauser helipad performed ten separate maneuvers with a Bell 206B Jetranger III helicopter. The maneuvers are shown below in the order in which they were performed.

1. Hover, East;
2. 62% flat pitch, idle, West;
3. Hover, West;
4. Hover, South;
5. 62% flat pitch, idle, South;
6. Takeoff, to South;
7. Approach, from North;
8. Takeoff, to South;
9. Approach, from North;
10. 62% flat pitch, idle, South.

Table 5.7 shows the noise levels recorded from the test maneuvers at the three measurement stations. Takeoff and approach maneuvers were executed directly over the measurement array. The

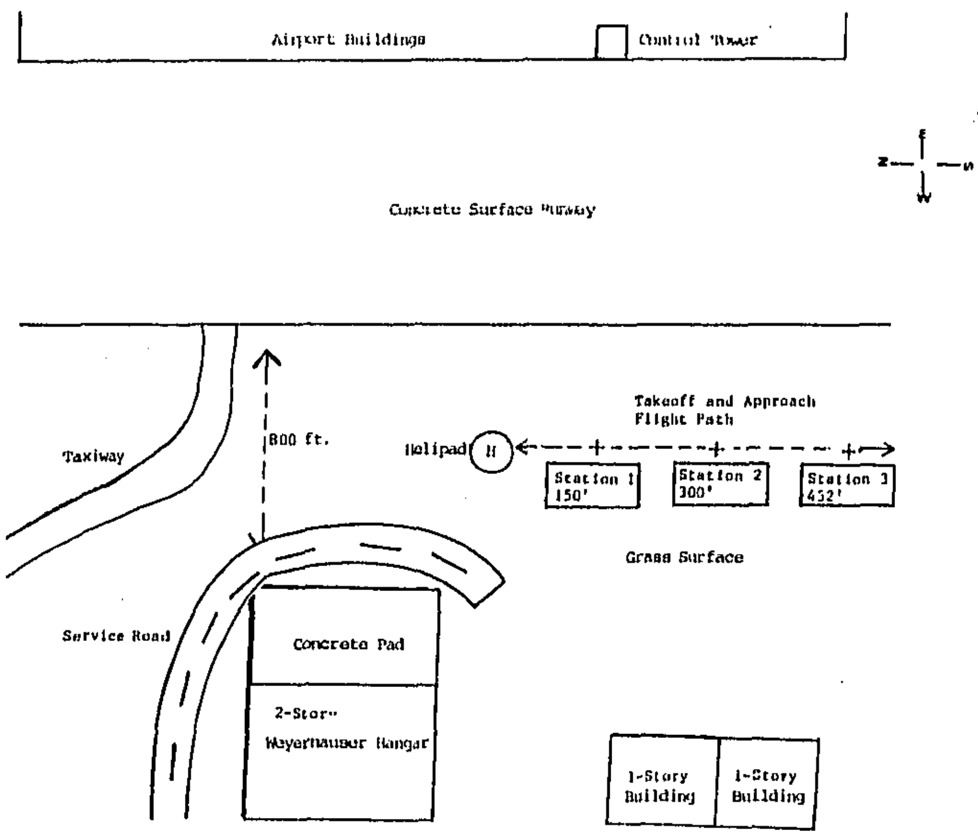


Figure 5.12 Site Schematic for Weyerhauser, Inc. Test Site

TABLE 5.7 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT WEYERHAUSER, INC.

Location: Weyerhauser, Inc.
Date: March 27, 1984
Time: 4:30 p.m.
Helicopter Model: Bell 206B Jet ranger III

Temperature: 53 F
Dew Point: 34
Wind Speed: 4 knots from South

Station	Dist. From Pad (ft.)	Hover (East) Time (sec.)	Leq	SEL	Lmax	Idle (East) Time (sec.)	Leq	SEL	Lmax	Hover (West) Time (sec.)	Leq	SEL	Lmax	Idle (West) Time (sec.)	Leq	SEL	Lmax	Hover (South) Time (sec.)	Leq	SEL	Lmax
1	160	32	87.1	102.1	90.4	34	76.8	91.0	82.4[1]	33	88.6	103.8	92.9[2]	34	74.4	89.6	78.7	34	82.1	97.4	81.8
2	300	31	78.3	93.2	80.7	-	-	-	-	34	85.4	100.7	91.3[2]	(1)33	62.0	77.1	81.3	33	78.0	91.1	77.8
3	452				72				70				74 [2]				81				70

Station	Dist. From Pad (ft.)	Idle (South) Time (sec.)	Leq	SEL	Lmax	Takeoff 1 Time (sec.)	Leq	SEL	Lmax	Approach 1[3] Time (sec.)	Leq	SEL	Lmax	Takeoff 2[3] Time (sec.)	Leq	SEL	Lmax	Approach 2[3] Time (sec.)	Leq	SEL	Lmax
1	160	33	69.7	84.8	71.2	16	88.9	100.9	95.9	21	90.2	103.3	98.0	12	90.2	100.9	96.0	36	90.7	106.2	100.9
2	300	32	62.8	77.8	64.4	16	84.6	96.8	91.3	22	85.3	98.6	94.6	12	86.7	97.4	92.9	38	84.6	100.4	93.9
3	452				59				87				88				90				88

All noise data were recorded with A-frequency weighting and slow response time averaging.
- = No data obtained due to equipment malfunction.
[1] = Lmax value includes portion of hover maneuver.
[2] = Measurement sample period includes passing 2-engine jet overhead.
[3] = Halo estimated at 50' altitude directly over Station 2 (visual judgement).

second takeoff was executed at a slightly shallower ascent angle than the first takeoff. As a result, the maximum sound levels recorded at Stations 2 and 3 are slightly higher on the second takeoff than the first takeoff.

The helicopter pilot also flew at a slightly steeper descent angle on the second approach than on the first. As a result, Station 1 recorded a maximum sound level almost 3 dB(A) higher on the second approach than the first approach. Figures 5.13, 5.14, and 5.15 show the graphic charts of all of the test maneuvers as recorded at Stations 1, 2 and 3 respectively.

Table 5.8 shows data obtained from two half-hour ambient noise samples at Station 3. Ambient noise Leq levels for the sample period with the helicopter test maneuvers (Leq of 71 dB(A)) and the sample period without the test maneuvers (Leq of 73 dB(A)) were not very different. This indicates that noise levels from the helicopter test maneuvers which lasted for approximately 15 minutes did not make a major contribution to existing ambient noise level. The highest maximum sound level measured during the first and second sample periods (91 dB(A) and 92 dB(A), respectively) were from jet takeoffs at the airport.

Table 5.9 shows maximum sound levels of non-helicopter noise events and helicopter test maneuvers recorded during the ambient noise samples at Station 3. Noise levels from jet takeoffs ranged from 74 dB(A) for a small business jet to 92 dB(A) for a large commercial two-engine jet. By comparison, maximum sound levels measured during the test landings and takeoffs ranged from 87 dB(A) to 90 dB(A) and noise levels from helicopter idle and hover maneuvers from 59 dB(A) to 74 dB(A).

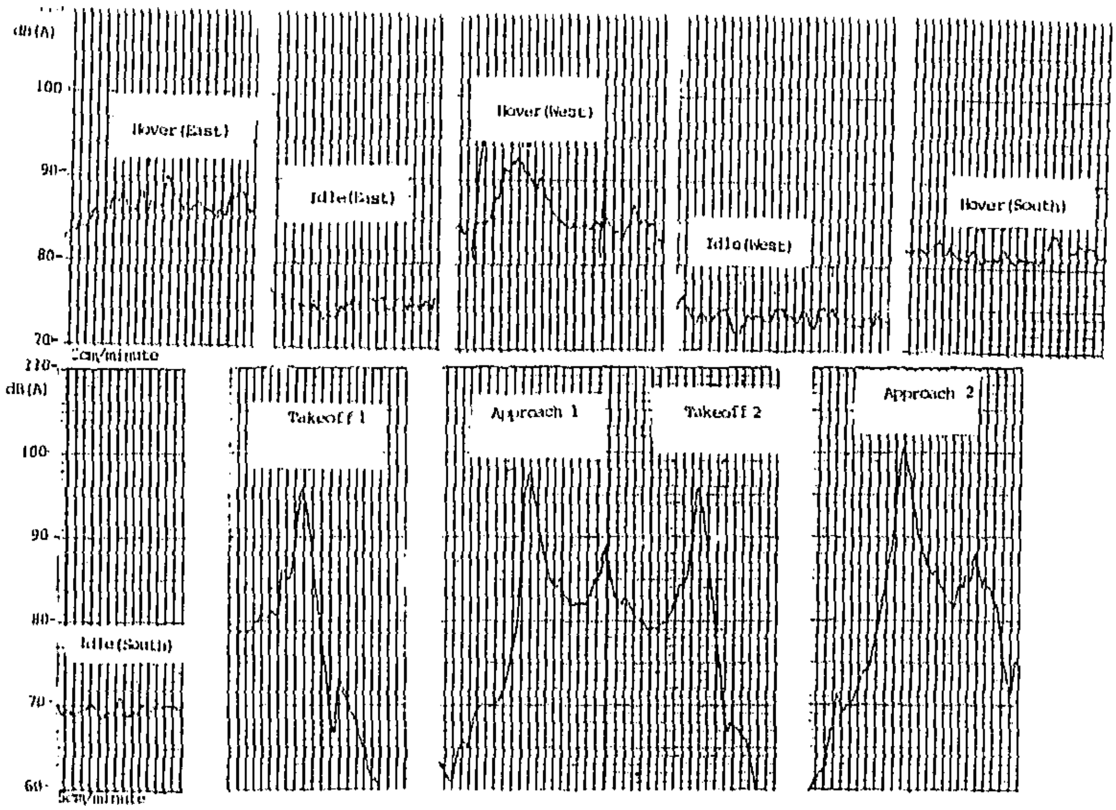


Figure 5.13 GLR Output for Weyerhauser, Inc. Test - Station 1

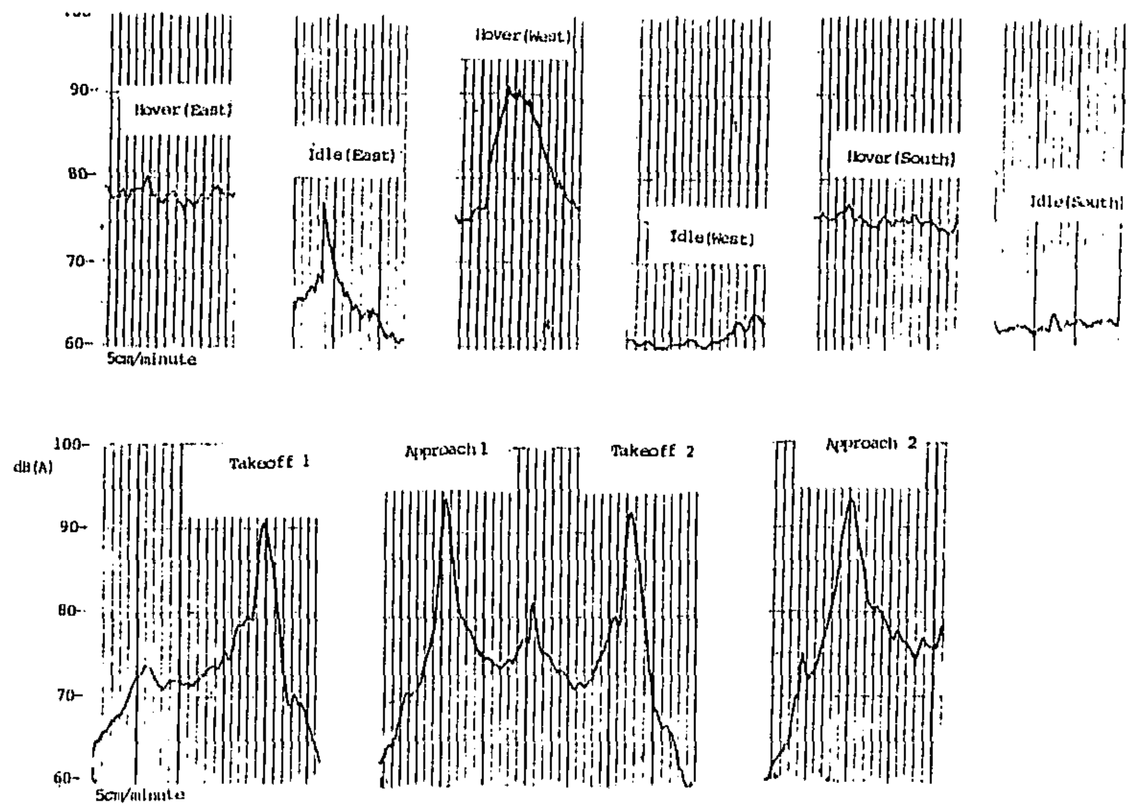


Figure 5.14 GLR Output for Weyerhauser, Inc. Test - Station 2

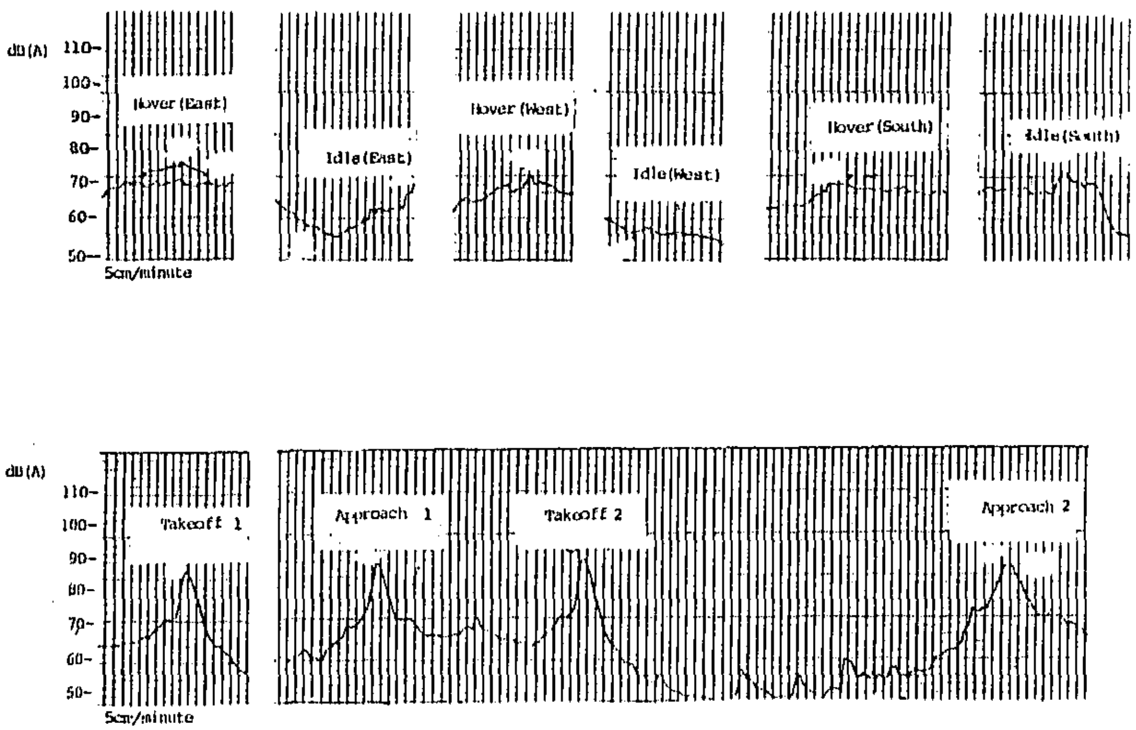


Figure 5.15 GLR Output for Weyerhauser, Inc. Test - Station 3

TABLE 5.8 AMBIENT NOISE LEVELS AT WEYERHAUSER, INC.

Location: Weyerhauser, Inc. (Station 3)
Date: March 27, 1984
Time: 4:23 p.m. – 5:37 p.m.
Helicopter Model: Bell 206B Jetranger III

Temperature: 63 F
Dew Point: 34
Wind Speed: 4 knots from South

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient with helicopter test maneuvers.	4:23-4:53	1/2 Hour	91(1)	90	87	70	56	45	43	42	71	2 GA t.o., 1 GA flyover, 2 3-engine jet landings, 1 jet flyover.
Ambient without helicopter test maneuvers.	5:07-5:37	1/2 Hour	92(2)	91	88	66	48	44	42	42	73	5 Jet to., 2 GA t.o., 3 jet landings, 3 GA flyovers, jet taxing 900 ft away.

All noise data were recorded with A-frequency weighting and slow response time averaging.

(1) = Lmax recorded from 2-engine jet takeoff at airport.
(2) = Lmax recorded from 2-engine jet takeoff at airport.

TABLE 5.9 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3 WEYERHAUSER, INC.

Location: Weyerhauser, Inc. (Station 3)
Date: March 27, 1984

Temperature: 53 F
Dew Point: 34
Windspeed: 4 knots from South

GA Operations:	Lmax
General Aviation Takeoff	70
General Aviation Takeoff	89
General Aviation Flyover	64
Jet Operations:	
Jet Takeoff	76
Jet Takeoff	81
Jet Takeoff	74
Small Jet Takeoff	82
Jet Takeoff	83
Jet Takeoff	92
Jet Landing (small jet)	60
Jet Landing (small jet)	60
Jet Taxing 900' away	57
Helicopter Test Manouvers:	
Hover(East)	72
Idle(East)	70
Hover(West)	74(1)
Idle(West)	61
Hover(South)	70
Idle(South)	59
Takeoff 1	87
Takeoff 2	90
Approach 1	89
Approach 2	88

All noise data were recorded with A-frequency weighting and slow response time averaging.
(1) Measurement sample period includes passing 2-engine jet overhead.

5.2.4 Seattle CBD Site 2

The helipad at CBD Site 2 is located approximately 70 feet above ground on the roof of a five story building in the Seattle Commercial Business District. This is location 2 in Figures 5.1 and 5.3. Land use in the vicinity of the helipad consists primarily of low-rise and mid-rise commercial and retail businesses. The Seattle Skydome and Exhibit Center are located approximately ten blocks to the north of the helipad. Elliott Bay and the waterfront tourist area are approximately a fourth of a mile to the west. Three noise monitoring stations were set up in an array extending 118 feet, 237 feet, and 355 feet north from the helipad. The helipad is located 70 feet above ground on the roof of a five story building in the Seattle Downtown Commercial District. Figure 5.16 shows a site schematic of the three noise monitoring station locations and the flight paths used for the takeoff and approach maneuvers.

All three stations were set up on asphalt surface parking lots. A small side street separated Station 1 from Stations 2 and 3. Background ambient noise levels were high because of moderate to heavy automobile traffic on nearby streets, and a mono rail that passed 25 feet from Station 3.

The helicopter pilot, using a Bell 206B Jetranger III helicopter, performed the following maneuvers in the order listed.

1. 100% flat pitch, idle, South;
2. Hover, North;
3. Hover, West;
4. 100% flat pitch, idle, West;
5. Hover, East;
6. Takeoff, to North;
7. Approach, from South;
8. Takeoff, to South.

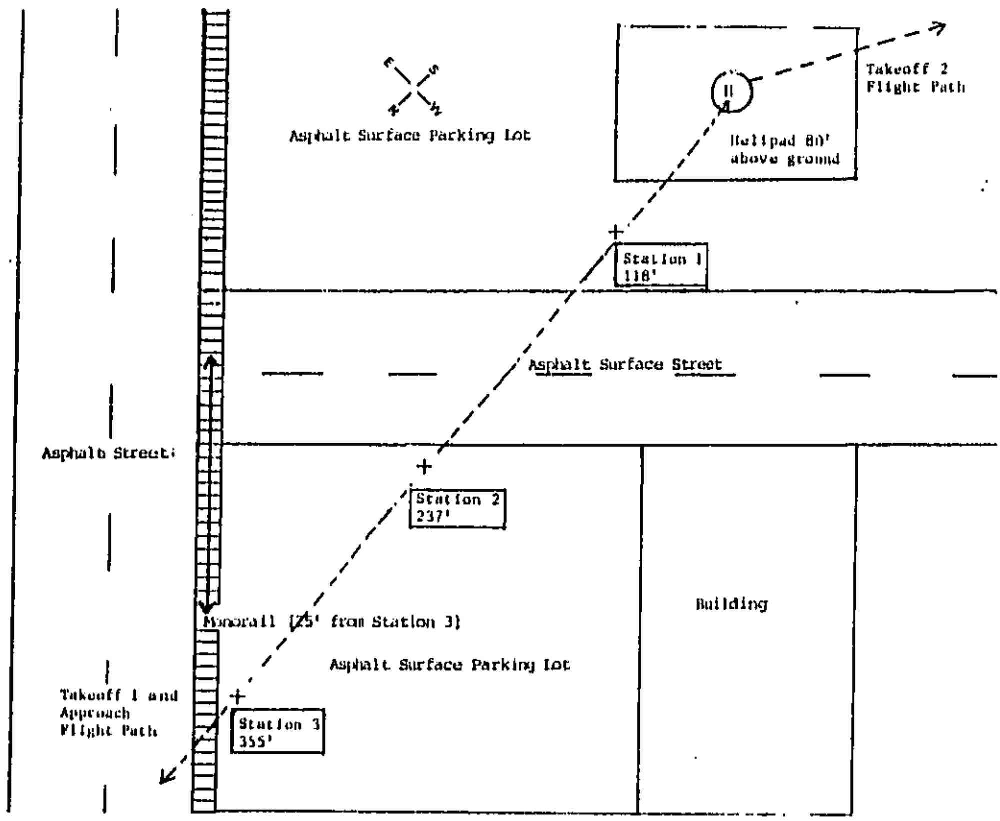


Figure 5.16 Site Schematic for Seattle CBD Site 2 Test Site

The first takeoff and the approach were executed directly over the measurement array. The second takeoff was executed south, away from the measurement array. The helicopter was fully loaded with passengers and cargo during all of the standardized test maneuvers.

Table 5.10 shows the noise levels recorded from the maneuvers at the three measurement stations. The helicopter descended at a very shallow angle on its approach over the noise measurement array. This accounts for the similar Lmax values measured between the three stations (less than 2 dB(A) between Station 1 and 3). The engine warmup and idle maneuver facing south could not be detected above existing background noise levels at Stations 2 and 3. In addition, station 3 could not detect the hover maneuver facing north. Figures 5.17 and 5.18 show the SPL graphic charts of all of the test maneuvers as recorded at Stations 2 and 3 respectively. No SPL graphic chart is available from Station 1 because of a malfunction of the Graphic Level Recorder.

Table 5.11 shows results from six ambient noise samples taken without the helicopter test maneuvers for periods ranging in duration from five minutes to 22 minutes that were recorded at Station 2 using a B & K sound level meter. Station 3 could not be used because of a CNA malfunction. Distributional exceedance and Leq data, therefore, could not be obtained. The malfunction, however, did not affect the sound pressure level display. Leq ambient noise levels in the absence of helicopter test maneuvers ranged from 62.6 dB(A) to 66.3 dB(A). Ambient Lmax values ranged from 71.8 dB(A) to 77.7 dB(A). Almost all of the helicopter idle and hover maneuvers recorded at Station 2 during the test had maximum sound levels within this range.

TABLE 5.10 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT SEATTLE CBD SITE 2

Location: Y
Date: March 28, 1984
Time: 10:25 a.m.
Helicopter Model: Bell 206B Jetranger III

Temperature: 46 F
Dew Point: 43
Wind Speed: 0 - 1 knots from South

Station	Dist. From Pad (ft.)	Warmup (South)				Idle (South)				Hover (North)				Hover (West)				Idle (West)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	110	47	67.7	84.3	72.2	38	74.0	89.7	75.2	28	75.2	89.7	78.6	30	76.0	91.5	78.1	44	73.0	89.4	74.4
2	237		*	*	*		*	*	*	34	72.3	87.6	71.6	31	73.9	88.7	78.1	43	72.5	88.8	74.2
3	355				*				*				*				73				72

Station	Dist. From Pad	Hover (East)				Takeoff 1 (North)				Approach[2]				Takeoff 2 (South)[1]			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	110	38	80.2	95.7	82.4	23	87.1	100.7	94.0	43	85.1	101.4	92.4	28	70.0	84.7	76.8
2	237	38	76.4	91.8	78.8	22	85.2	99.6	90.5	43	83.9	100.2	92.8		72.2	86.8	76.1
3	355				74				91				91				74

All noise data were recorded with A-frequency weighting and slow response time averaging.
[1] = Helicopter at 55' altitude directly over Station 2 (photo scaling).
[2] = Helicopter at 58' altitude directly over Station 2 (photo scaling).
* = Background noise too high to detect maneuver.

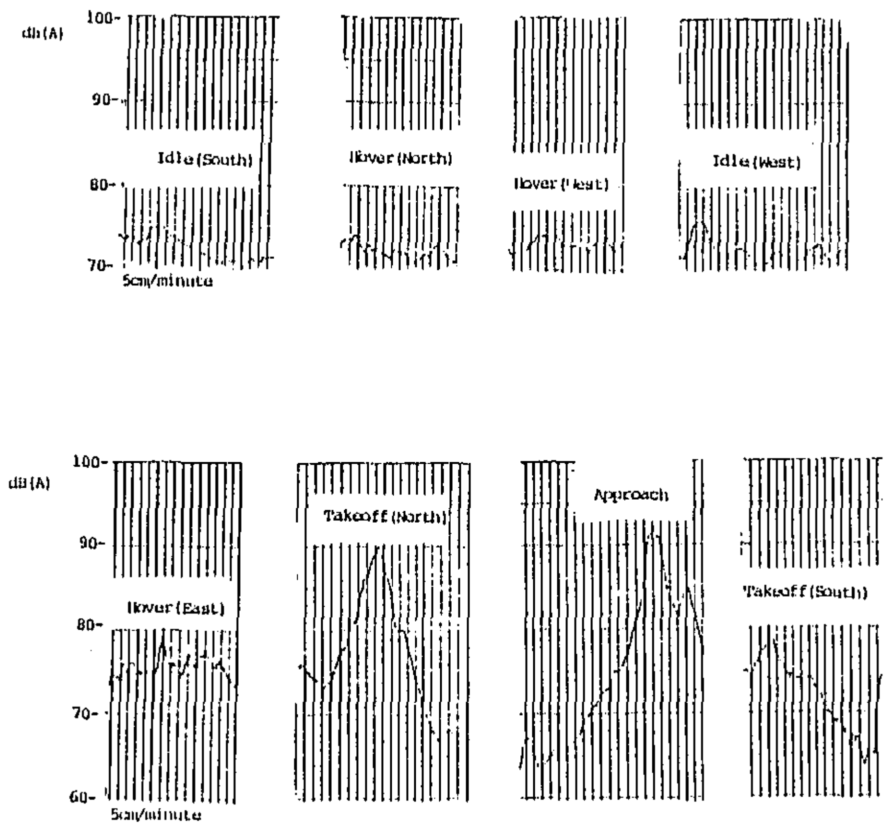


Figure 5.17 GLR Output for Seattle CBD Site 2 Test - Station 2

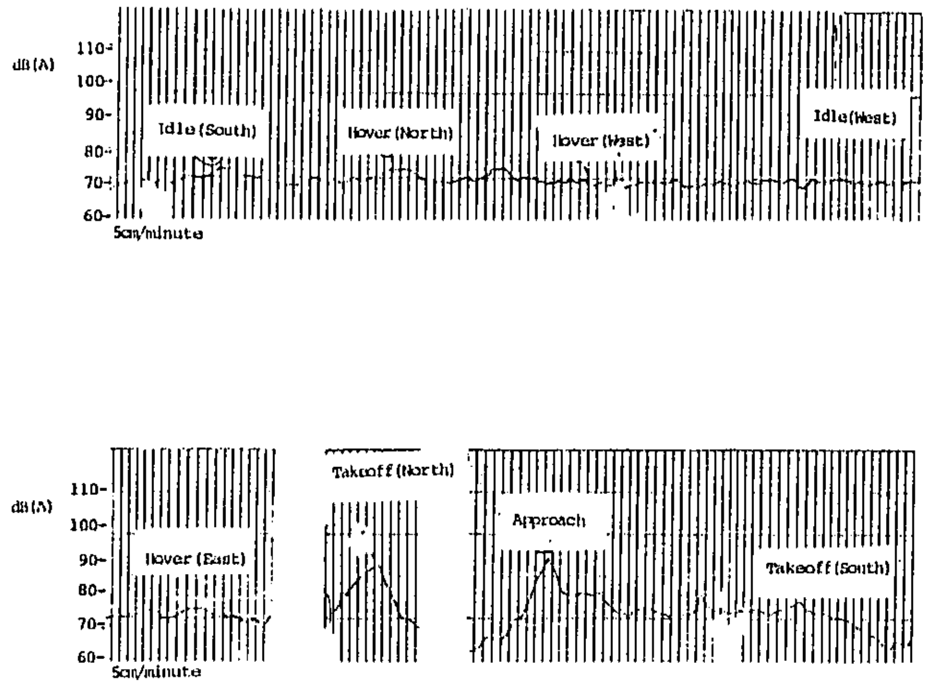


Figure 5.18 GLR Output for Seattle CBD Site 2 Test - Station 3

TABLE 5.11 SELECTED AMBIENT NOISE LEVELS AS RECORDED AT
STATION 2 SEATTLE CBD SITE 2

Location: Seattle CBD Site 2 (Station 2)
Date: March 28, 1984

Temperature: 48 F
Dew Point: 43
Wind Speed: 0 – 1 knots from South

Ambient Description	Measurement Duration (seconds)	Leq	SEL	Lmax	
Ambient with moderate automobile traffic present	600	62.7	90.4	71.8	(1)
Same as above	602	63.1	91.3	77.7	(1)
Same as above	1346	62.8	93.8	75.8	(1)
With moderate traffic and monorail	343	65.3	90.5	77.0	(2)
With moderate traffic	503	60.3	93.2	73.2	(1)
Same as above.	865	64.3	93.5	73.9	(1)

All ambient noise data were recorded with a B & K ISLM with A-frequency weighting and slow response time averaging.

(1) = Lmax value is due to car or truck traffic on street.
(2) = Lmax value is due to monorail passing 75 feet from microphone.

Table 5.12 shows Lmax values of selected non-helicopter noise events and the helicopter test maneuvers recorded at Station 3. The highest non-helicopter Lmax value recorded was from a fire truck which passed 40 to 50 feet from the microphone and registered 91 dB(A). This is the same Lmax value recorded at Station 3 for the takeoff and approach maneuvers directly over the station. A monorail that passed over the street adjacent to Station 3 registered Lmax values that ranged from 71 dB(A) to 83 dB(A). By comparison, the idle and hover maneuvers detected at Station 3 registered Lmax values between 72 dB(A) and 74 dB(A).

5.3 ACTUAL IN-SERVICE HELICOPTER OPERATIONS

Noise levels from several actual in-service helicopter operations was measured at four locations in the Seattle commercial business district. This area was selected because it has the highest concentration of helicopter operations in Seattle. Figure 5.19 shows a map that indicates the locations of the four noise measurement sites.

Two monitoring stations were set up near the Edgewater Inn helipad to measure noise levels from an idle and two takeoff maneuvers. The Edgewater Inn helipad is located in the waterfront tourist area. This area is primarily retail stores and restaurants located in piers extending over Elliott Bay. The Downtown Commercial Business District is directly to the east of the helipad. The downtown area consists of commercial and retail businesses. The Seattle harbor area is located a fourth of a mile to the south of the helipad.

The helipad is located on a wooden deck which extends from the edge of the parking lot at Edgewater Inn over Elliott Bay. Station 1 used a B&K ISLM and was set up in the asphalt parking lot of Edgewater Inn 119 feet from the helipad. Station

TABLE 5.12 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3 SEATTLE CBD SITE 2

Location: Seattle CBD Site 2 (Station 3)
Date: March 28, 1984

Temperature: 46 F
Dew Point: 43
Wind Speed: 0 - 1 knots from South

Street Traffic:	Lmax
Bus	78
Bus	71
Bus	78
Bus	77
Bus	75
Buses (two)	81
Bus	71
Car	70
Car	65
Car	66
Car (accelerating)	71
Car (accelerating)	77
Car	72
Car (backfire)	78
Truck	85
Fire Engine	91
Truck Horn	78
Monorail:	
Monorail	83
Monorail	73
Monorail	80
Monorail	71
Monorail	73
Helicopter Test Maneuvers:	
Hover(West)	73
Idle(West)	72
Hover(East)	74
Takeoff 1 (North)	91
Takeoff 2 ,(South)	74
Approach	91
Miscellaneous:	
(727) Jet Flyover	74 (727)

All noise data were recorded with A-frequency weighting and slow response time averaging.

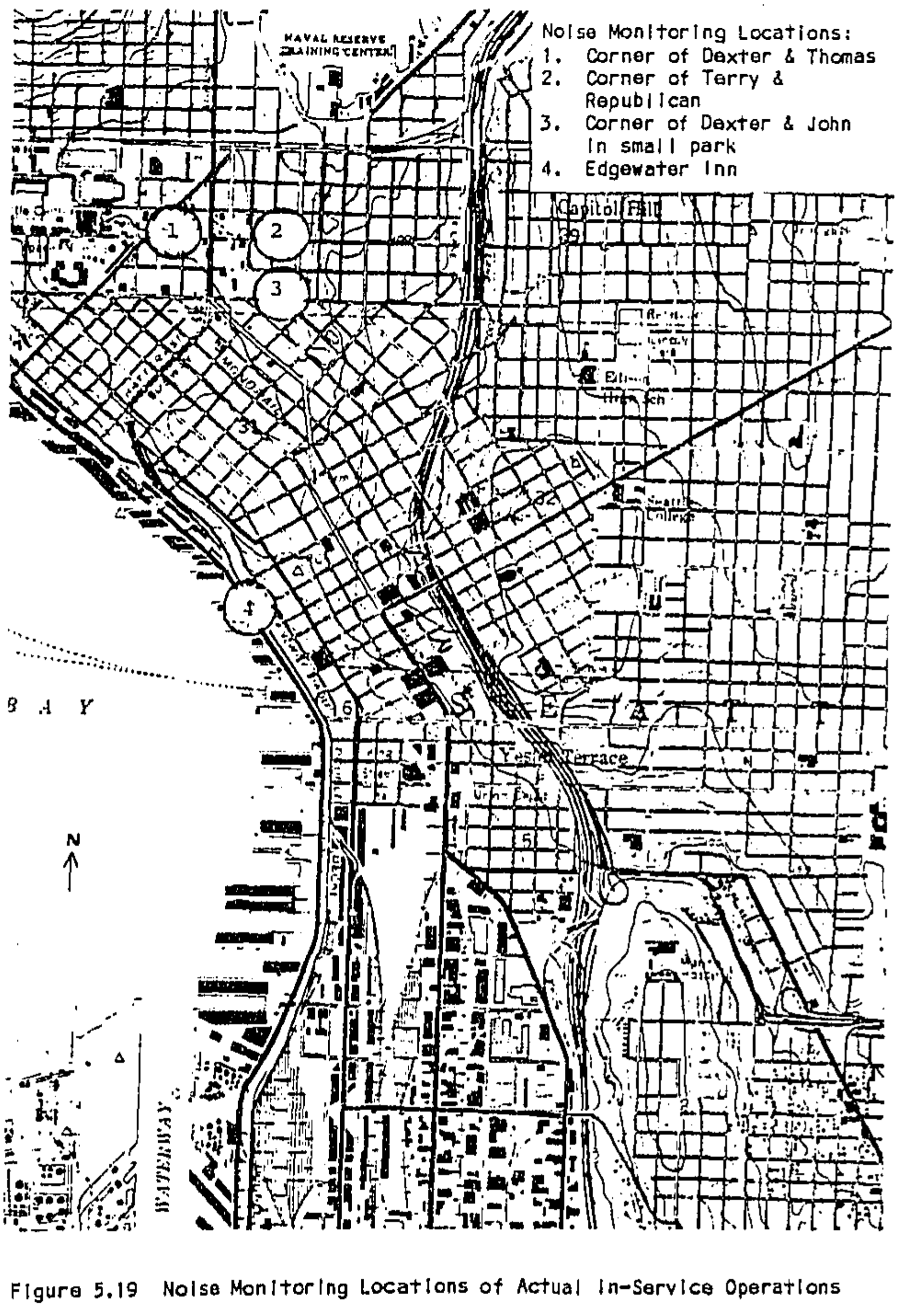


Figure 5.19 Noise Monitoring Locations of Actual In-Service Operations

2 used a CNA and was set up on a concrete sidewalk across a four-lane street 250 feet from the helipad. Background ambient noise levels were high due to moderate automobile traffic, occasional street cars, and train traffic in the vicinity of the helipad.

Three other noise monitoring stations were also set up in the Seattle Commercial Business district. The first was located on a concrete sidewalk near the corner of Dexter Street and Thomas Street. Thomas Street had very light automobile traffic; however, Dexter Street was continuously busy with moderate to heavy automobile traffic. The second station was located in a light manufacturing area on an asphalt parking lot near the corner of Terry Street and Republican Street. Street traffic in the immediate vicinity of this station was light, which resulted in a relatively low ambient noise level. The third station was located in an open, grassy area at the corner of Dexter Street and John Street. Street traffic on both of these streets was moderate to heavy. Land use in the vicinity of all three of these stations was primarily composed of low-rise commercial and business establishments with some high-rise buildings located within ten blocks of the stations.

Table 5.13 shows the noise data obtained from all of the noise measurement locations. Lmax levels from actual in-service helicopter operations ranged from 62 dB(A) to 91.3 dB(A). The highest Lmax value measured was from a Bell 206B Jetranger III helicopter takeoff at the Edgewater Inn helipad. With the exception of the two takeoff operations, maximum helicopter noise levels were within the range of maximum levels usually reported for non-helicopter urban noise sources such as heavy trucks, buses, and automobile traffic. Helicopter traffic was relatively light; only 14 operations were observed during a five hour monitoring period from noon to 5:00 p.m.

TABLE 5.13 NOISE DATA FOR ACTUAL IN-SERVICE HELICOPTER OPERATIONS

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Helicopter flyover 300-500 ft away, a Hughes 500D	1	300-400	20	68.9	83.4	72.2
206 Bell running east to west perpendicular to station.	1	500	10	60.6	70.8	62.4
Helicopter flyover	1	[2]	20	77.0	90.8	81.7
Helicopter flew 400 ft behind station 2	1	300	13	70.8	81.9	72.1
Helicopter flew in front of Space Needle 500 ft from station	1	300	30	68.5	83.2	75.8
Helicopter over KING T.V.	1	250	20	68.5	81.5	70.7
Helicopter flyover	2	[2]	48	65.0	81.8	69.1
Helicopter 800' perpendicular to Terry St.	2	500	8	63.7	72.7	70.4
Helicopter S. to N. close to station.	3	500	[1]	[1]	[1]	85
Helicopter N. to S. close to station.	3	500	[1]	[1]	[1]	84
Helicopter from east without traffic.	3	500	[1]	[1]	[1]	80

All noise data were recorded with A-frequency weighting and slow response time averaging.
* = See Figure 5.10 for station locations.
[1] = Noise levels measured with the CNA which is not capable of recording measurement duration, Leq, and SEL readings for single events.
[2] = Not able to estimate altitude.

(Table continued)

(Table 5.13 continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Bell 206B ground idle 110' away.	4	NA	25	67.4	81.3	69.1
Bell 206B takeoff beginning 110' away and leading away from station.	4	30	14	76.6	88.1	82.1
Same operation as above beginning 250' away, flying toward station, then turning back in opposite direction.	4	30	[1]	[1]	[1]	84
Bell 206B Jet-ranger III(modified from Jetranger II) takeoff beginning 110' away and heading away from station.	4	30	19	84.4	97.2	91.3

All noise data were recorded with A-frequency weighting and slow response time averaging.
* = See Figure 5.19 for station locations.
[1] = Noise levels measured with the CNA which is not capable of recording measurement duration, Leq, and SEL readings for single events.
[2] = Not able to estimate altitude.

CHAPTER 6

RESULTS OF THE HELICOPTER NOISE SURVEY
IN
PORTLAND, OREGON

This chapter presents the results of the helicopter noise survey performed in Portland, Oregon. The chapter is divided into three sections. Section 6.1 presents a general overview of helicopter operations relative to land use patterns in Portland. Section 6.2 presents noise measurement data obtained from standardized helicopter maneuvers and land use characteristics at four helipad test sites. Section 6.3 presents noise measurement data obtained from monitoring actual in-service helicopter operations in the Portland area.

6.1 OVERVIEW OF HELICOPTER OPERATIONS RELATIVE TO LAND USE PATTERNS AND NOISE

As helicopter traffic in urban areas increases, so does the concern that helicopter noise might adversely impact noise-sensitive land use areas, such as residential districts, schools, and parks. It is a result of this concern in Portland that several steps have been taken by city officials to help minimize the effect of noise in these areas. For example, the city requires helipad operators to obtain conditional-use permits. These permits require helicopter operators to adhere to specific takeoff and approach routes established to reduce the helicopter noise impact on noise sensitive residential districts.

So far, helicopter operators have not been required to use specific routes or operational procedures to reduce the noise impact when flying at cruise altitude. However, the city encourages helicopter operators, whenever possible, to observe certain flight guidelines designed to minimize the noise exposure of residential and other noise sensitive areas. These include:

- Using the areas above waterways, freeways, and railroad tracks as helicopter flight paths;
- Curtailing the number of helicopter flights during the nightime hours of 10:00 p.m. to 7:00 a.m.;
- Following industry-wide noise abatement procedures, such as those published by the Helicopter Association International ["Fly Neighborly Program", Helicopter Association International, February 1982].

According to operational data obtained from helicopter operators, and airport and city officials, there are currently 13 helipads located in the Portland area. Figures 6.1 and 6.2 show the locations of these helipads. Noise tests using standardized maneuvers were performed at locations 1, 2 and 3 in Figure 6.1 and at location 13 in Figure 6.2. Locations 1, 2 and 3 are in Portland; location 13 is situated three miles to the east of the Portland city limits in Beaverton, Oregon. Land use patterns in the neighborhoods of the Portland and Beaverton helipads are shown in Figures 6.3 and 6.4, respectively.

Seven of the helipads (locations 1-7 in Figures 6.1 and 6.3) are in the downtown Central Business District (CBD) of Portland at a television station, three public utility facilities, a bank, a hospital, and a site designated by the city of Portland as a temporary public use helipad. The television station helipad is located approximately 50 feet above ground on the roof of KATU-TV. The only helicopter operating from this helipad is used to cover news stories and report traffic conditions. The use of this helipad varies, but is generally not more than two or three operations per day.

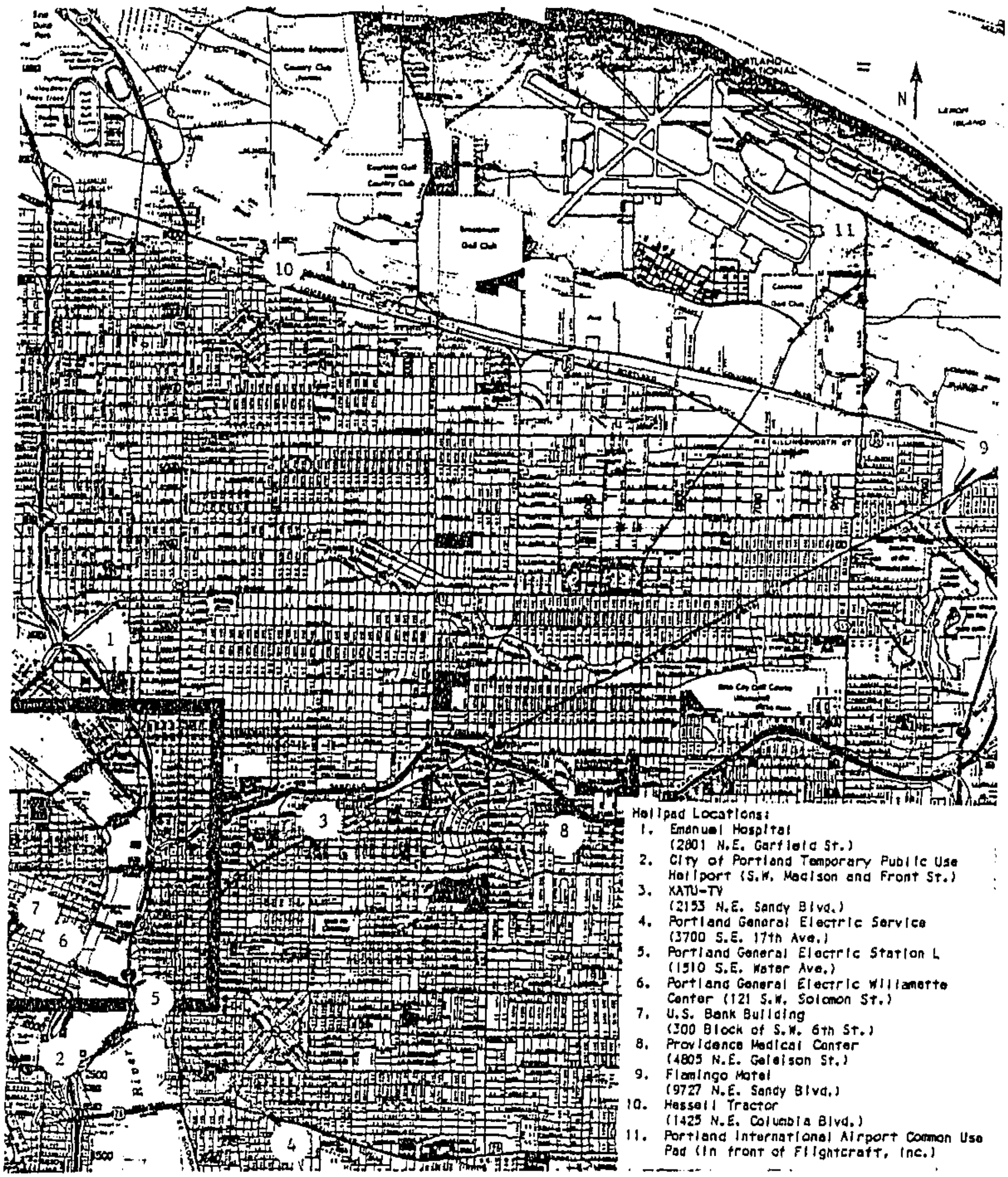


Figure 6.1 Location of Helipads in Portland

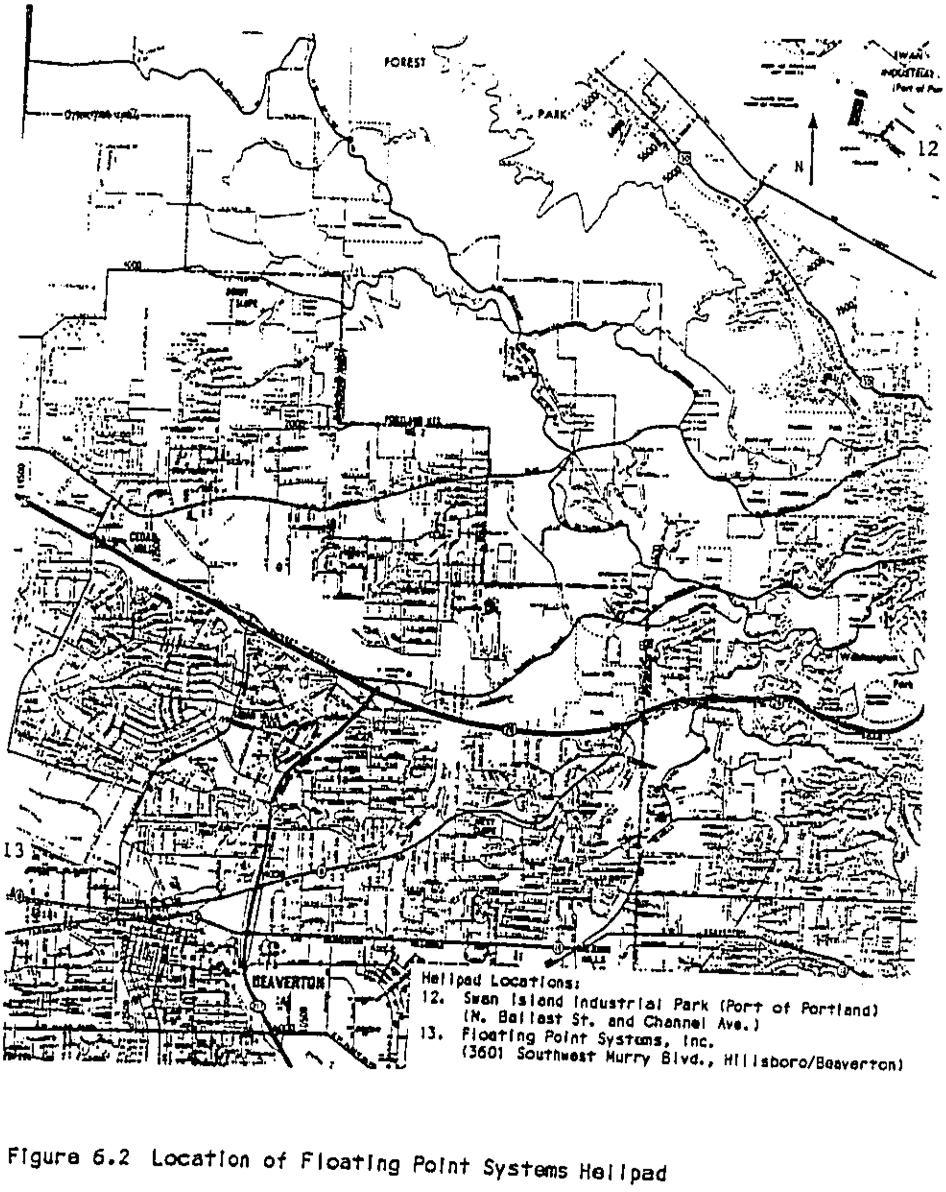
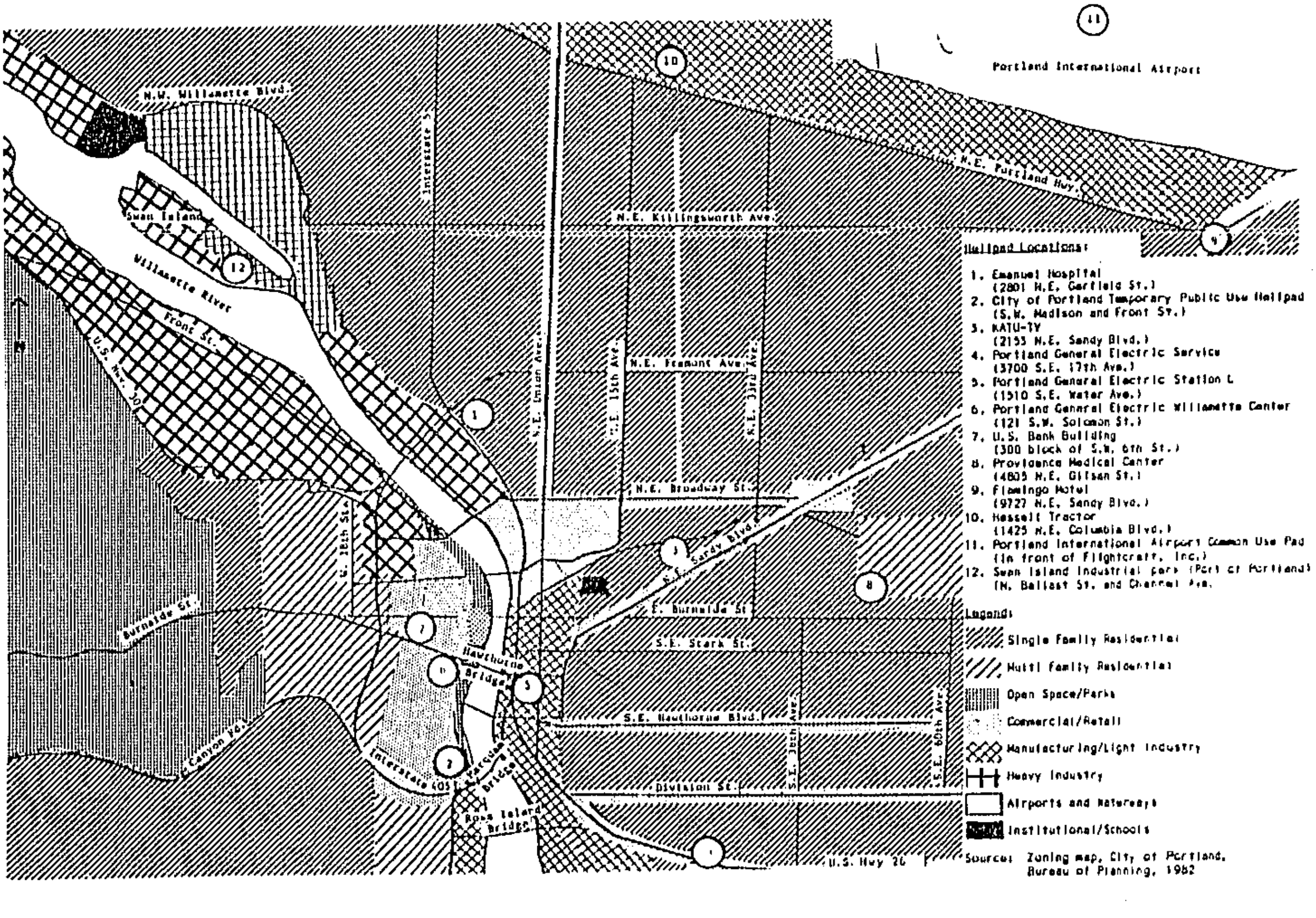
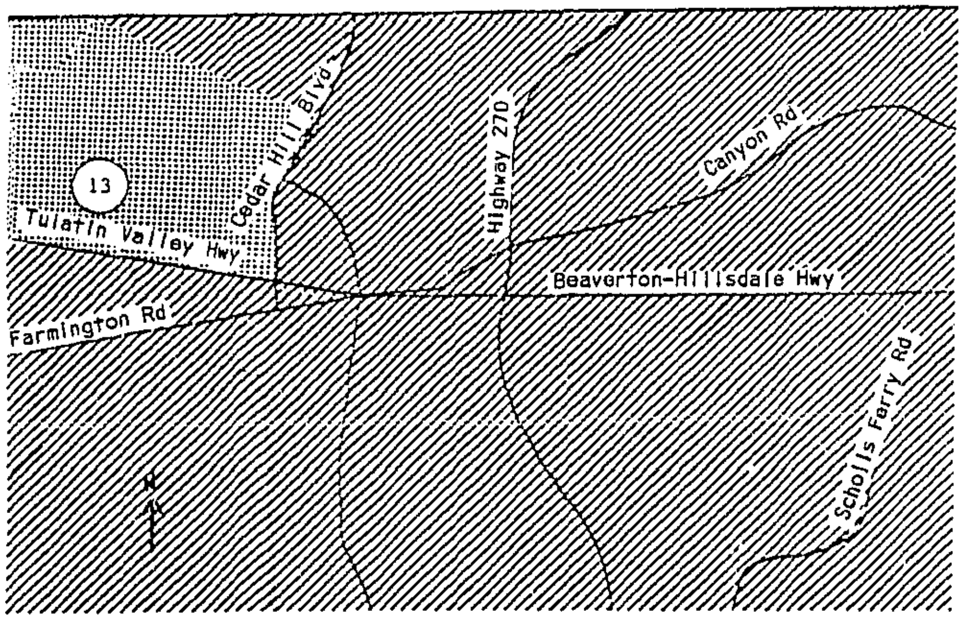


Figure 6.2 Location of Floating Point Systems Helipad



6.3 Land Use Characteristics of Portland in Relation to Existing Helipads



Helipad Locations:
13. Floating Point Systems, Inc.
(3601 Southwest Murry Blvd., Hillsboro/Beaverton)

Legend:

Single Family Residential

Open Space/Parks

Commercial/Retail

Source: Zoning map, City of Portland

Figure 6.4 Land Use Characteristics in Relation to Floating Point Systems in Beaverton, Oregon

The three public utility helipads are owned and operated by the Portland Gas and Electric Company. One of these is located on the roof of a highrise office building and the other two are at street level. Helicopter operations from all three of these helipads are for transportation of personnel and electric powerline monitoring. The helipad located 258 feet above ground on the roof of the U.S. Bank building is used primarily for executive personnel transportation.

The helipad located on the roof of Emanuel Hospital, approximately 75 feet above ground, is used mainly for search and rescue operations, or patient transportation between hospitals. Daily usage averages one or two operations per day.

A temporary public use helipad is located in Portland on the eastbank of the Willamette River near the CBD and may be used by any helicopter operator. KGW Television, for example, utilizes the helipad as a base for some of their news story operations. The number of operations at the temporary public use helipad averages approximately two per day.

Land use in the downtown CBD, in the immediate vicinity of these seven helipads, is primarily commercial and retail businesses with some light manufacturing industries. A zone of light manufacturing and heavy industry extends northwest and east of the CBD along both sides of the Willamette River. Large areas of open space and parks lie immediately to the west of the industrial zone. Medium and low density single family detached residential dwellings lie to the southwest of the CBD. Land use to the east of the industrial zone is primarily medium and high density attached residential dwellings.

Helicopters using the helipads in the CBD and flying north or south generally fly along the Willamette River or Interstate 5. Helicopters flying into and out of the helipads from east and west generally fly along U.S. Highway 84 to the east and U.S. Highway 26 to the west.

The other six helipads in the Portland area (locations 8-12 in Figures 6.1 and 6.3 and location 13 in Figures 6.2 and 6.4) are located on the outer fringes of the city at the Providence Medical Center, the Flamingo Motel, Hessell Tractor Inc., Portland International Airport, Swan Island Industrial Park, and Floating Point Systems, Inc.

The Providence Medical Center helipad is located at street level and is used almost entirely for emergency helicpoter ambulance service. The medical center does not keep a helicopter at the hospital; estimated usage is less than ten operations per month. Land use around the medical center is primarily residential, although there are some commercial and retail businesses along the major streets in the area.

The Flamingo Motel, located a few blocks south of the Portland International Airport, has a rooftop helipad for use by motel guests. The number of operations is relatively infrequent. Land use to the east, south and west of the motel is primarily medium and high density residential housing with some commercial and retail businesses located along the road leading to the airport.

Hessell Tractor, Inc. has a street level helipad located at their warehouse in North Portland. Helicopter operations are used primarily for the transportation of heavy equipment; there are approximately 80 helicopter operations per year. Land use in the neighborhood of this helipad is light manufacturing and heavy industry. Medium and high density attached residential housing is located to the south of the helipad.

The Port of Portland maintains two street level helipads: one at the Portland International Airport, and the other at the Swan Island Industrial Park; both are located primarily in heavy industry areas.

The corporate helipad at Floating Point Systems, Inc. is located at street level in the corner of a parking lot. Helicopter operations consist mainly of the transportation of executive personnel. Operations are infrequent, averaging less than ten per month. Land use around the helipad is primarily low density single family detached housing with commercial and retail businesses located along two major roadways within one mile of the helipad.

6.2. STANDARDIZED MANEUVER TESTS

Four helicopter models were tested in Portland: a Messerschmitt BoelKow BO 105, a Bell 206B Jetranger III, an Agusta A109A, and a Hughes 500D (with modified four-bladed tail rotor designed to reduce noise emissions). Manufacturers' specifications for these helicopters are shown in Appendix B. Noise monitoring stations were set up to measure noise levels resulting from standardized helicopter test maneuvers at four helipads in the Portland area. Three of the helipads chosen were privately owned: Emanuel Hospital, Floating Point Systems Inc., and KATU-TV. The fourth was the Portland temporary public use heliport. Sections 6.2.1 through 6.2.4 describe the locations of the noise monitoring stations, the helicopter test maneuvers and the noise measurement data obtained at each of the four helipad test sites.

6.2.1 Emanuel Hospital

The Emanuel Hospital helipad (location 1 in Figures 6.1 and 6.3) is located approximately 75 feet above ground on the roof of the hospital. The hospital is located one-half mile to the east of the Willamette River. Interstate 5 runs north-south approximately 800 feet to the west of the hospital, between the river and the hospital. Land use to the west and south of the hospital, along Interstate 5 and the Willamette River, is primarily light manufacturing industry and commercial establishments, with the exception of a small park adjacent to the south parking lot of the hospital. High density single family residential houses and apartment buildings lie to the east and north of the hospital.

Three noise monitoring stations were set up in an array extending 227 feet, 372 feet, and 516 feet northwest of the helipad. Figure 6.5 shows the locations of the noise monitoring stations as well as the flight paths used for the takeoff and approach maneuvers. Station 1 was located approximately 50 feet west of the hospital building on a concrete sidewalk at the corner of two side streets. Station 2 was located across the street from Station 1 on an asphalt surface parking lot approximately 60 feet west of the hospital. Station 3 was located on a grassy area north of the parking lot approximately 70 feet west of the hospital. Traffic on the side street near the hospital was light to moderate.

Background ambient noise levels near the hospital were relatively low. Several short duration ambient noise samples registered Leq levels that ranged between 58dB(A) and 62dB(A). Intrusive noise sources came primarily from traffic on the side roads near the hospital and from Interstate 5.

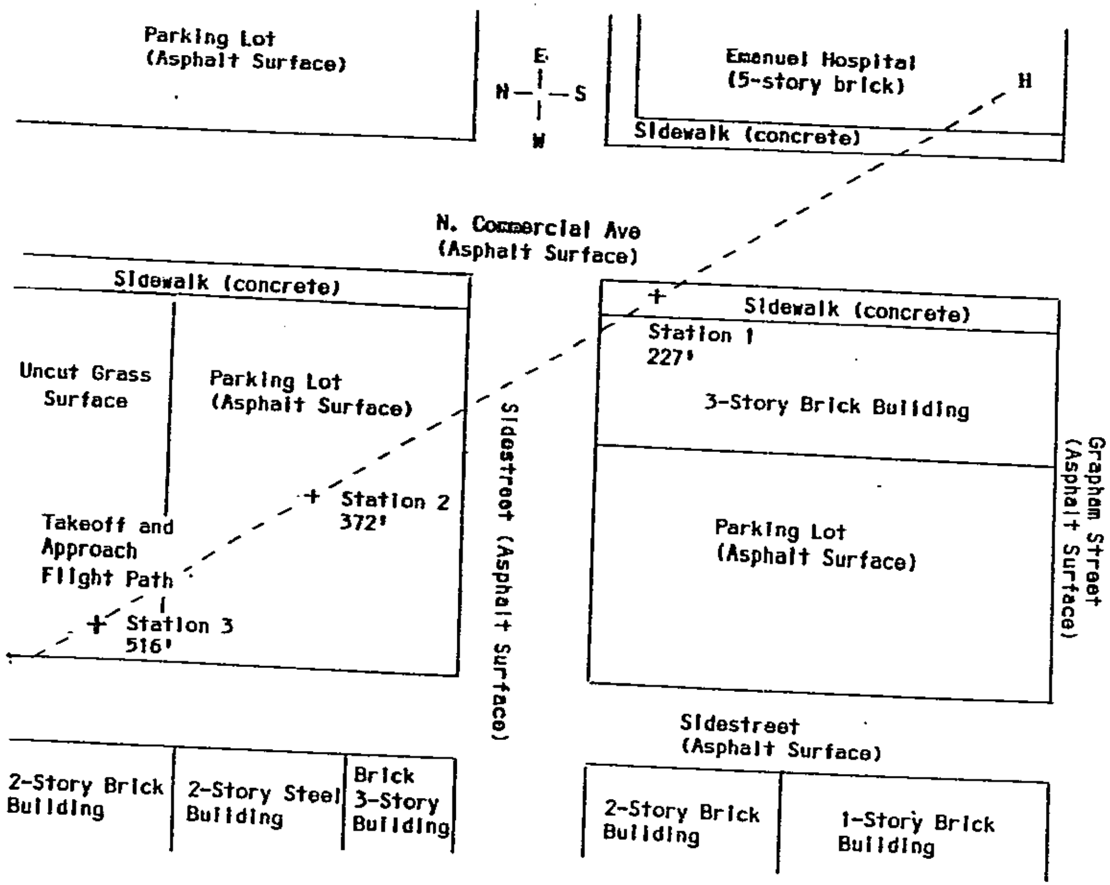


Figure 6.5 Site Schematic For Emanuel Hospital Helipad Test 1

The helicopter pilot at Emanuel Hospital performed eleven separate operations with a BO 105 helicopter. The operations performed for the test are shown below in the order in which they were performed:

1. 100% flat pitch, idle, West;
2. Hover, West;
3. Hover, South;
4. 100% flat pitch, idle, South;
5. Hover, East;
6. 100% flat pitch, idle, East;
7. Hover, North;
8. 100% flat pitch idle, North;
9. Takeoff, to North;
10. Approach, from North;
11. Takeoff, to North.

Table 6.1 shows the noise levels recorded from the test maneuvers at the three measurement stations. The Lmax values obtained were 6dB(A) to 8dB(A) higher for idle and hover maneuvers facing east than for the same maneuvers facing west. One possible explanation for this may be due to the orientation of the tail rotor and exhaust in relation to the measurement array. The tail rotor, faced the measurement array during maneuvers facing east, and faced away from the measurement array during maneuvers facing west. Similarly, Lmax values measured at the three monitoring stations were 8dB(A) to 9dB(A) higher for idle and hover maneuvers facing south (with the tail rotor and exhaust facing towards the measurement array) than for idle and hover maneuvers facing north (with the tail rotor and exhaust facing away from the measurement array).

TABLE 6.1 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT EMANUEL HOSPITAL

Location: Emanuel Hospital
Date: April 23, 1984
Time: 2:00 p.m.
Helicopter Model: Messerschmitt BO 105

Temperature: 55 F
Dew Point: 34
Wind Speed: 8 knots from NW

Station	Dist. From Pad (ft.)	100% Approach Time (sec.)	Leq	SEL	Lmax	Hover (West) Time (sec.)	Leq	SEL	Lmax	Hover (South) Time (sec.)	Leq	SEL	Lmax	100% Idle (South) Time (sec.)	Leq	SEL	Lmax	Hover (East) Time (sec.)	Leq	SEL	Lmax
1	227	30	00.0	05.4	70.0	30	81.5	06.3	03.0	21	00.5	89.0	80.0	20	70.7	03.1	00.3	10	87.8	00.0	90.3
2	372	37	00.1	03.7	70.6	30	77.6	02.4	70.0	21	03.4	06.0	06.0	26	70.4	80.2	82.2 [1]	16	84.6	00.0	80.7
3	518				60				75				85				70				81

Station	Dist. From Pad (ft.)	100% Idle (East) Time (sec.)	Leq	SEL	Lmax	Hover (North) Time (sec.)	Leq	SEL	Lmax	100% Idle (North) Time (sec.)	Leq	SEL	Lmax	Takeoff 1 [1] Time (sec.)	Leq	SEL	Lmax	Approach [3] Time (sec.)	Leq	SEL	Lmax
1	227	23	70.0	83.4	70.7	23	77.0	91.5	70.5	20	70.8	85.3	72.3	10	83.8	06.6	07.5	32	70.1	81.1	80.5
2	372	23	76.7	00.3	00.5 [1]	23	75.1	88.7	77.2	25	69.8	83.0	71.4	10	82.4	85.1	80.0	15	75.0	87.0	70.4
3	518				75				78				70				85				78

Station	Dist. From Pad (ft.)	Takeoff 2 [2] Time (sec.)	Leq	SEL	Lmax
1	227	17	83.0	88.0	07.7
2	372	17	82.0	84.2	85.0
3	518				85

[1]=Lmax from trancelver voice interference from helicopter pilot for approximately four seconds.
[2]=Helicopter estimated at 215 feet altitude directly over Station 1 (photo scaling).
[3]=No altitude estimate available due to camera malfunction. (visual judgement).

All noise data were recorded with A-frequency weighting and slow response time averaging.

The two takeoffs and the approach were executed directly over the measurement array. There was little difference observed between the Lmax levels recorded at the three stations for the takeoffs and the approach. This is attributable to the very shallow ascent and descent angles used by the pilot. The sound pressure level time graphs recorded at Stations 1, 2, and 3 for each maneuver are shown in Figures 6.6, 6.7, and 6.8, respectively.

Table 6.2 presents the ambient noise level data recorded at Station 3 for three, one-hour consecutive sample periods. The first sample period includes the helicopter test maneuvers which lasted for approximately 11 minutes; the other two do not. All three sample periods included light automobile and truck traffic on a side road 75 feet to the east of the microphone. The data indicate that the helicopter test maneuvers increased the hourly average sound level (Leq) at this location by 6dB(A) in each of two sample periods, and 10 dB(A) in the third period.

Table 6.3 shows Lmax values recorded at Station 3 for non-helicopter noise events that occurred during the ambient noise sample periods and the Lmax values recorded from the helicopter test maneuvers. The highest Lmax value (85dB(A) recorded during the sample periods occurred during the test helicopter takeoff maneuvers. The highest Lmax value recorded for a non-helicopter noise source was generated by a heavy truck, 45 feet away from the microphone, and registered 80dB(A).

6.2.2 City of Portland Temporary Public Use Heliport

The Portland temporary public use heliport is located on a small grassy area at the foot of Marquam Bridge (Interstate 5) on the west bank of the Willamette River (location 2 in Figures 6.1 and 6.3). This heliport is used for transient helicopter

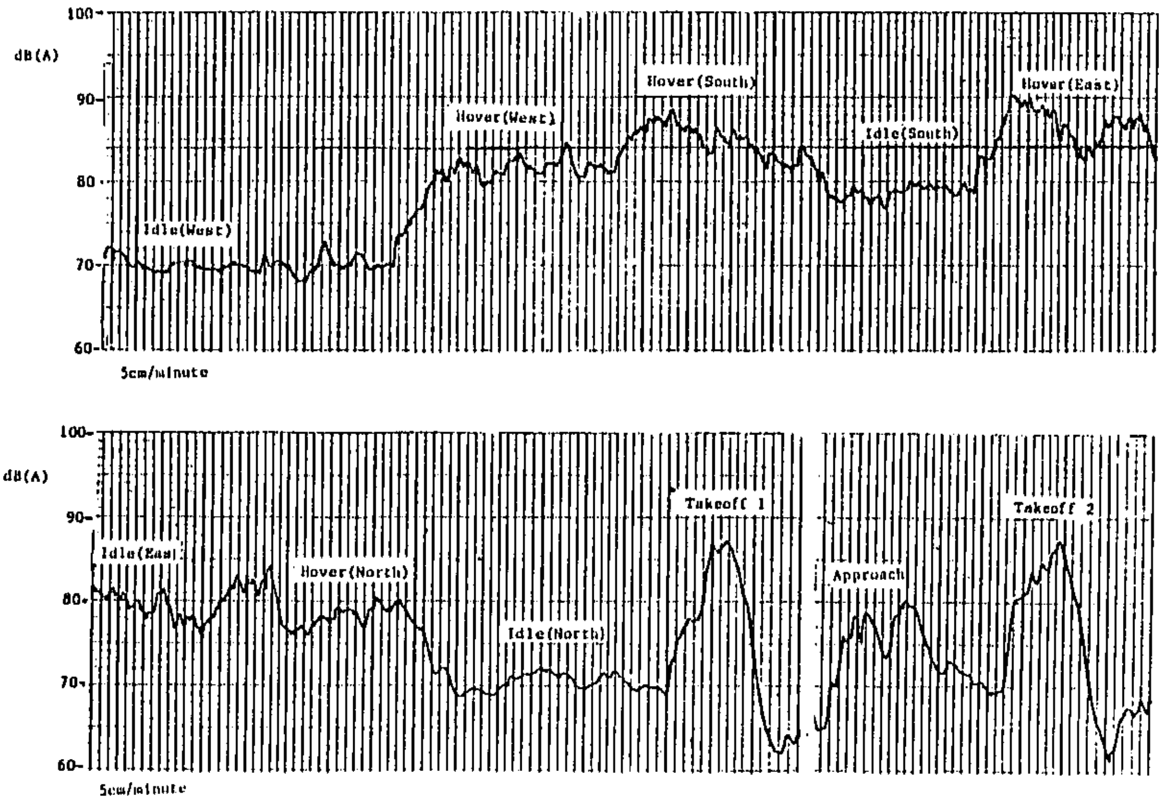


Figure 6.6 GLR Output for Emanuel Hospital Test - Station 1

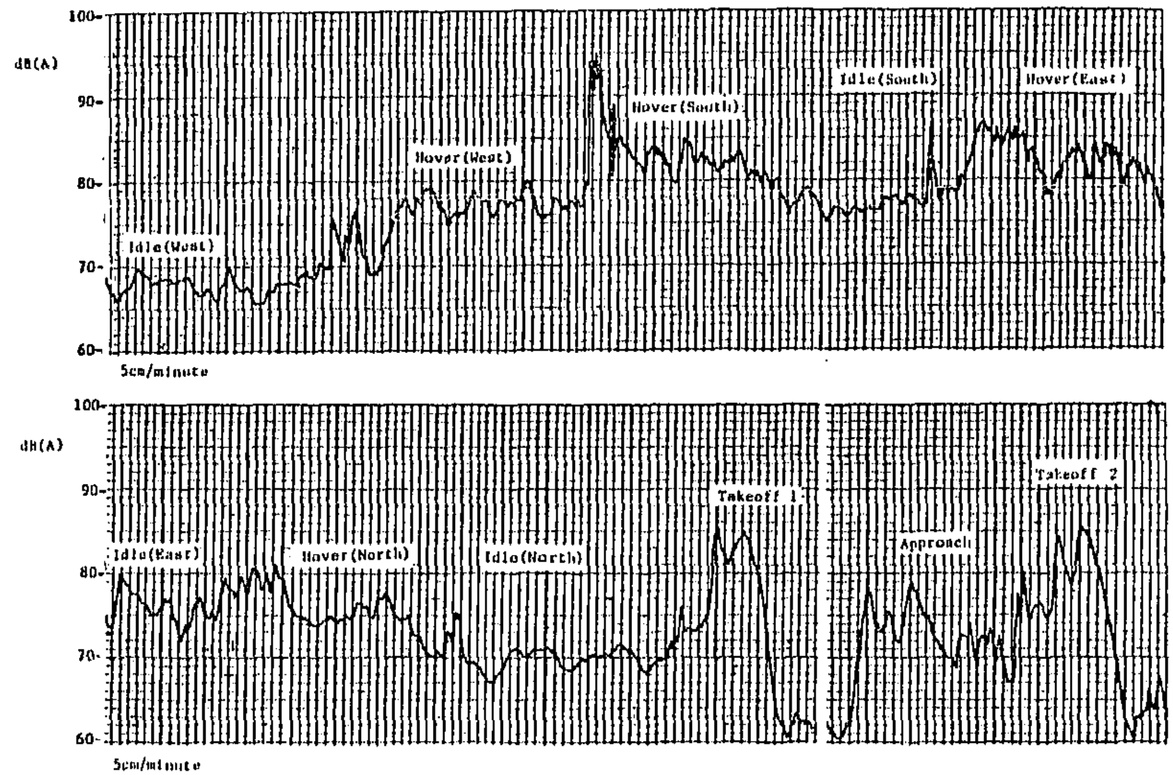


Figure 6.7 GLR Output for Emanuel Hospital Test - Station 2

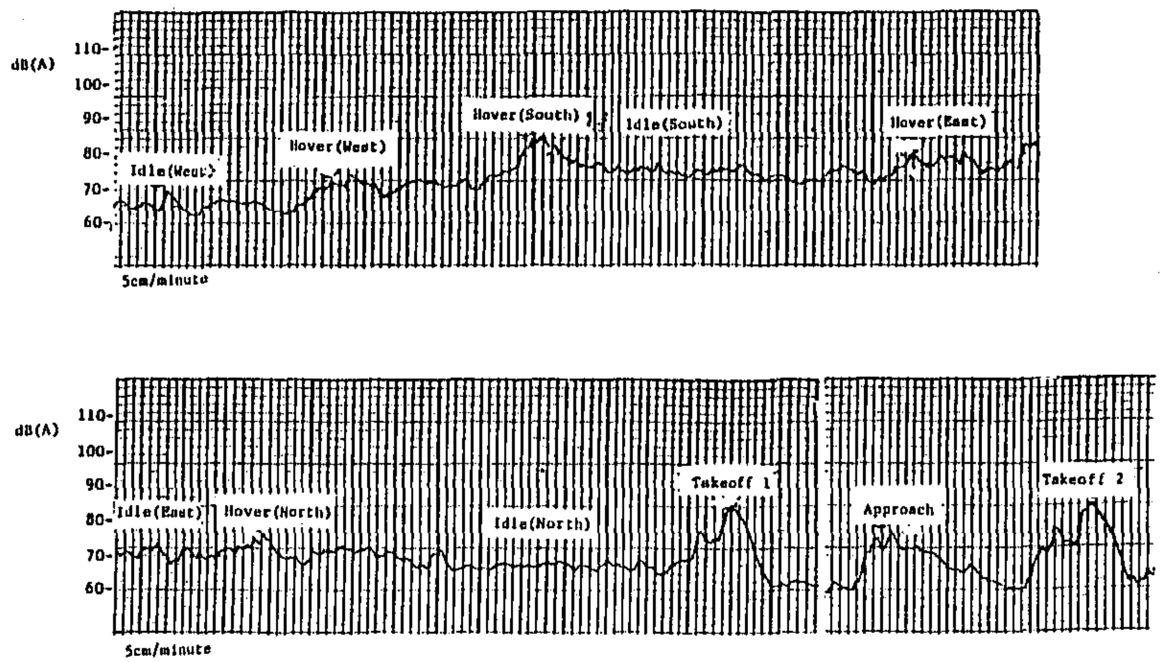


Figure 6.8 GLR Output for Emanuel Hospital Test - Station 3

TABLE 6.2 AMBIENT NOISE LEVELS AT EMANUEL HOSPITAL

Location: Emanuel Hospital
Date: April 23, 1984
Time: 1:27 p.m.-4:35 p.m.
Helicopter Model: Messerschmitt BO 105

Temperature: 55 F
Dew Point: 34
Wind Speed: 8 knots from NW

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient with helicopter test maneuvers.	1:27-2:27	1 Hour	85	85	81	71	57	55	54	54	68	Includes light automobile and truck traffic on side road 75' away.
Ambient without helicopter test maneuvers.	2:32-3:32	1 Hour	74(1)	-	-	-	57	55	53	53	58	Includes very light automobile and truck traffic on side road 75 feet away, jet flyover.
Ambient without helicopter test maneuvers.	3:35-4:35	1 Hour	80(2)	78	74	63	58	56	55	54	62	Included light automobile and truck traffic on side road 75' away.

All data were recorded with A-frequency weighting and slow response time averaging.
- = no valued obtained due to equipment malfunction.
(1) = Lmax recorded from large jet flyover. Value obtained from graphic chart.
(2) = Lmax recorded from passing heavy truck.

TABLE 6.3 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT EMANUEL HOSPITAL

Location: Emanuel Hospital (Station 3)
Date: April 23, 1984
Time: 1:27 p.m.-4:35 p.m.

Temperature: 55 F
Dew Point: 34
Wind Speed: 8 knots from NW

Event

Traffic:	Lmax		Lmax
Car door slam 7' away.	81	Large car starting 15' away.	81
Pickup truck with dual exhaust 75 feet away.	62	Motorcycle 15' away.	88
Car horn 30' away.	80	Automobile backfire.	82
Heavy truck without trailer 45 feet away.	80	Passing truck 45' away.	64
Heavy truck with trailer 45 feet away.	65	Volkswagon starting 8' away.	64
		Volkswagon 15' away.	70
		Large motorcycle.	89
Heavy truck with trailer 45 feet away.	67	Aircraft:	
Dump truck 45 feet away.	73	Jet overhead behind clouds.	74
Ambulance 120 feet away.	61	One prop. Cessna overhead behind clouds.	62
Pickup truck with dual exhaust 15 feet away.	65	Jet overhead behind clouds.	85
Car door close 10' away.	02	Jet overhead behind clouds.	60
Van parking 20' away.	61	Jet overhead behind clouds.	88
Dumptruck 2/10 mile away.	62	One-prop Cessna overhead.	80
Heavy truck with trailer 45 feet away.	64	Miscellaneous:	
Dumptruck 2/10 mile away.	60		
Car with dual exhaust 15' away.	80	Hammering at nearby construction site.	61
Small car starting.	64		
Truck 45 feet away.	59	Birds chirping nearby.	56
Car starting 10' away.	62		
Pickup truck starting 15' away.	80	Helicopter test maneuvers:	
Passing truck.	63		
Passing dumptruck.	80	Idle(West)	68
Heavy truck with trailer 45 feet away.	80	Hover(West)	75
		Hover(South)	85
Volkswagon 15' away.	62	Idle(South)	78
Small car starting 15' away.	65	Hover(East)	81
		Idle(East)	75
		Hover(North)	78
		Idle(North)	70
		Takeoff 1	85
		Approach	78
		Takeoff 2	85

All noise data were recorded with A-frequency weighting and slow response time averaging.

operations. It is situated between two large interstate highways: Interstate 405 to the west and south, and Interstate 5 to the east across the Willamette River. A one block wide strip of park land runs north-south on the western bank of the Willamette River adjacent to the heliport. The CBD is located to the north and west of the helipad and consists of commercial and retail establishments. Land use across the Willamette River to the east and southeast of the heliport is categorized as light manufacturing industries. Land use to the south and southwest of the heliport is medium density multi-family and low density single family detached housing.

Three noise monitoring stations were set up in an array extending 112 feet, 270 feet, and 435 feet north of the heliport, as shown in Figure 6.9. Station 1 was located on a grassy area next to a service road; Stations 2 and 3 were located on a vacant dirt field. The Willamette River runs parallel to the measurement array approximately 200 feet to the east; barge traffic was present on the river during the tests. A four-lane divided street (Front Street) runs parallel to the measurement array approximately 800 feet to the west; moderate automobile and truck traffic were present during the tests. However, background ambient noise levels at the heliport were relatively low. Leq ambient noise levels ranged from 55 dB(A) to 60dB(A). Infrequent barge traffic on the river and street traffic on Front Street were the primary sources of intrusive noise. Freeway traffic from Marquam Bridge also contributed somewhat to the background ambient noise levels.

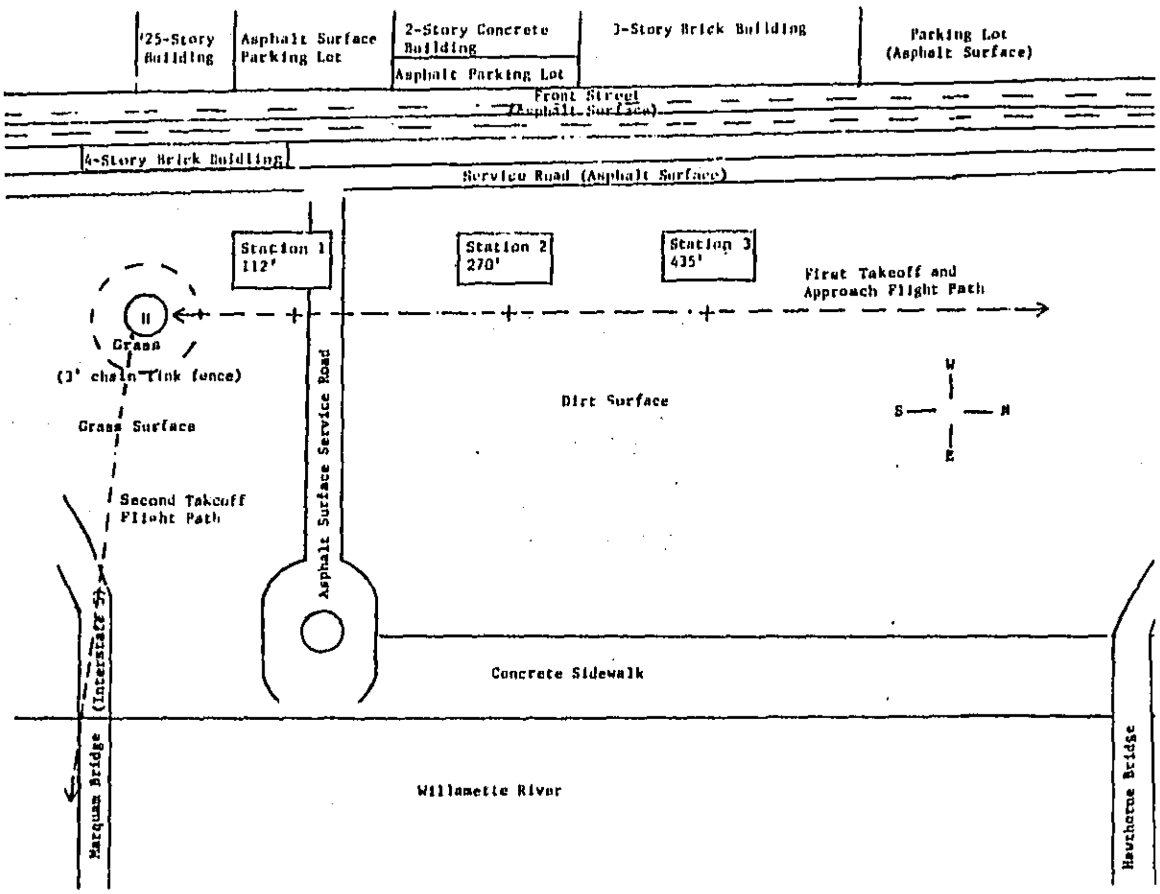


Figure 6.9 Site Schematic For City of Portland Temporary Public Use Heliport Test 2

A Bell 206B Jetranger III helicopter from KGW Television was used for the test. The pilot performed twelve separate maneuvers shown below in the order in which they were performed:

1. 100% flat pitch, idle, West;
2. Hover; West;
3. 100% flat pitch, idle, South;
4. Hover, South;
5. 100% flat pitch idle, East;
6. Hover, East;
7. 100% flat pitch idle, North;
8. Hover, North;
9. Takeoff, to North;
10. Approach, from North;
11. Engine cool down, West;
12. Takeoff, to East.

Table 6.4 shows the noise levels recorded during the test maneuvers at the three measurement stations. The Lmax values recorded at the measurement stations were only slightly higher (less than .2dB(A) at stations 1 and 2, and 2dB(A) at Station 3) for the idle facing east than for the idle facing west. Lmax values recorded at the measurement stations were 2dB(A) to 4dB(A) higher for the hover facing east than for the same maneuver facing west. One explanation for this difference in Lmax values may be that the tail rotor and exhaust ports faced the measurement array during the idles and hover-east maneuvers, and faced away from the measurement array during the idles and hover west maneuvers. Similarly, Lmax and Leq values from idle and hover maneuvers facing south (tail rotor towards measurment array) were higher than for the same maneuvers facing north (tail rotor facing away from the measurement array).

TABLE 6.4 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT CITY OF PORTLAND TEMPORARY PUBLIC USE HELIPORT

Location: Temporary Public Use Heliport
Date: April 24, 1984
Time: 8:30 a.m.
Helicopter Model: Bell 206B Jetranger III

Temperature: 44 F
Weather: Light Drizzle and Hail
Wind Speed: 0 – 3 knots from E

Station	Dist. From Pad (ft.)	100% Idle (West)				Hover (West)				100% Idle (South)				Hover (South)				100% Idle (East)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	112	30	81.0	96.5	83.2	32	81.3	96.3	82.9	34	82.6	97.9	83.8	32	82.2	97.2	83.0	35	81.1	96.5	83.4
2	270	31	71.0	85.7	72.8	32	71.9	86.9	73.7	35	72.3	87.7	74.2	32	72.4	87.4	75.3	35	70.2	85.5	73.1
3	435				68				71				72				73				71

Station	Dist. From Pad (ft.)	Hover (East)				100% Idle (North)				Hover (North)				Takeoff (1)				Approach (2)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	112	33	84.6	99.8	86.8	33	78.0	93.2	79.0	34	78.6	94.8	80.8	17	84.5	96.8	91.2	39	85.4	101.3	95.0
2	270	32	73.5	88.5	76.1	34	68.7	83.8	70.1	36	69.6	85.0	71.1	14	82.2	93.6	87.5	15	76.0	87.0	87.1
3	435				73				67				70				84				85

All noise data recorded with A-frequency weighting and slow response time averaging.
-* no data obtained due to equipment malfunction
* Background noise too high to detect maneuver.
[1]=Helicopter estimated at 75' altitude directly over Station 1 (photo scaling directly over Station 1 (photo scaling).
[2]=Helicopter estimated at 80' altitude directly over Station 1 (photo scaling).

(Table continued on next page)

TABLE 6.4 (continued)

Station	Dist. From Pad (ft.)	Cooldown (West)				Takeoff (East)[+]			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	112	26	68.9	83.0	71.1	20	63.4	76.4	80.6
2	270	27	62.5	76.8	64.3	-	-	-	-
3	435				*				80

All noise data recorded with A-fequency weighting and slow response time averaging.
-=no data obtained due to equipment malfunction.
* Background noise too high to detect maneuver.
[+]=Noise data not directly comparable with corresponding data in other tests. See text.

The first takeoff and approach maneuvers were executed directly over the measurement array. The second takeoff maneuver was executed to the east, perpendicular to the measurement array. (For this reason, the takeoff data is not directly comparable to to other takeoff data). On the approach maneuver, the helicopter maintained a very shallow descent angle as it approached over Stations 3 and 2, hovered for ten seconds over Station 2, and then continued its descent at a steeper angle to the helipad. This may explain why there is only a difference of 2dB(A) in Lmax values between Stations 3 and 2 and a 5dB(A) difference between Stations 2 and 1 for the approach maneuver. The sound pressure level time graphs recorded at Stations 1, 2, and 3 for each maneuver are shown in Figures 6.10, 6.11, and 6.12, respectively.

Table 6.5 shows noise data obtained from two, one-hour ambient noise samples measured at Station 3. A malfunction in the CNA resulted in the loss of some of the exceedance level data for the second one-hour sample. Inclement weather conditions did not permit a third ambient noise sample to be taken. The first ambient noise sample period included the helicopter test maneuvers which lasted for approximately 30 minutes, as well as a passing helicopter overflight. The second ambient noise sample did not include the helicopter test maneuvers. However, it did include two helicopter overflights. The data indicates that the noise emitted from the helicopter test maneuvers added 6dB(A) to the average hourly Leq level without the helicopter test maneuvers.

Table 6.6 presents Lmax values recorded at Station 3 for non-helicopter noise and for the helicopter test maneuvers that occurred during the periods of testing and ambient noise measurement. The maximum noise levels recorded during the ambient noise sample periods were 84dB(A) and 85dB(A) from the

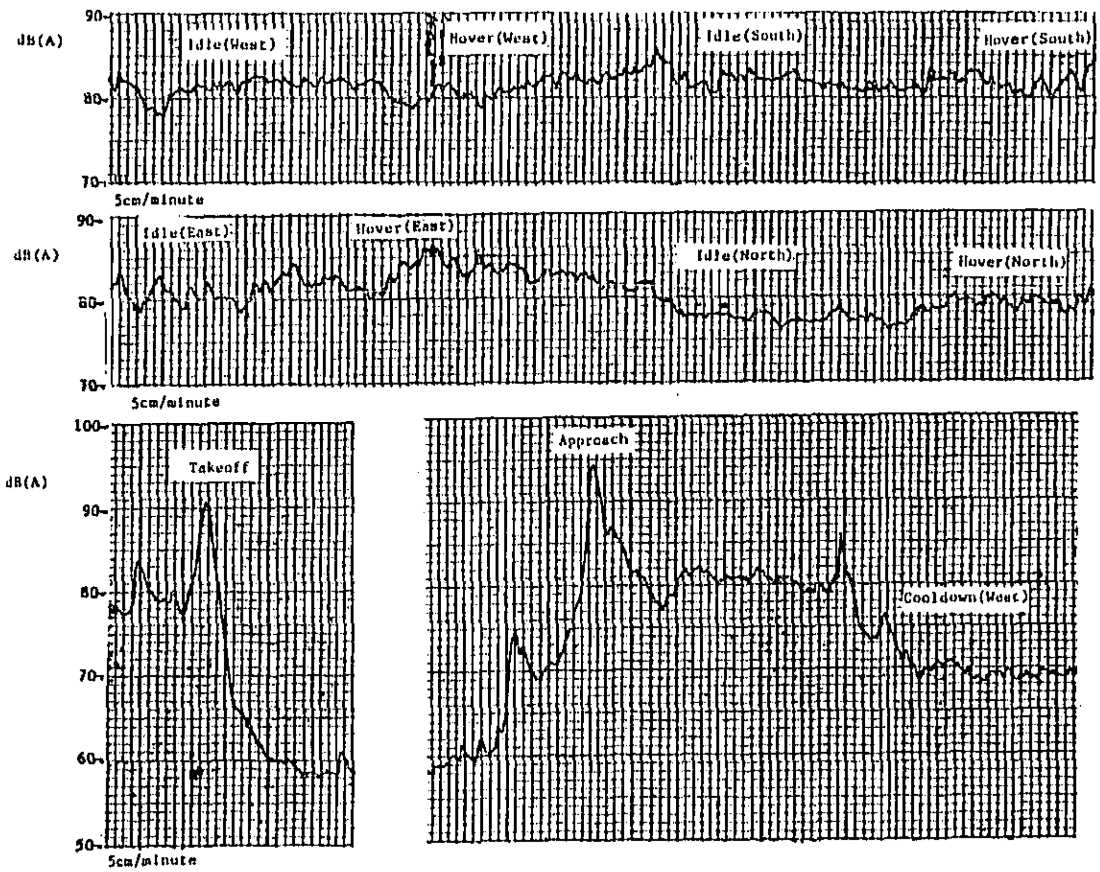


Figure 6.10 GLR Output for City of Portland Temporary Public Use Heliport Test Station 1

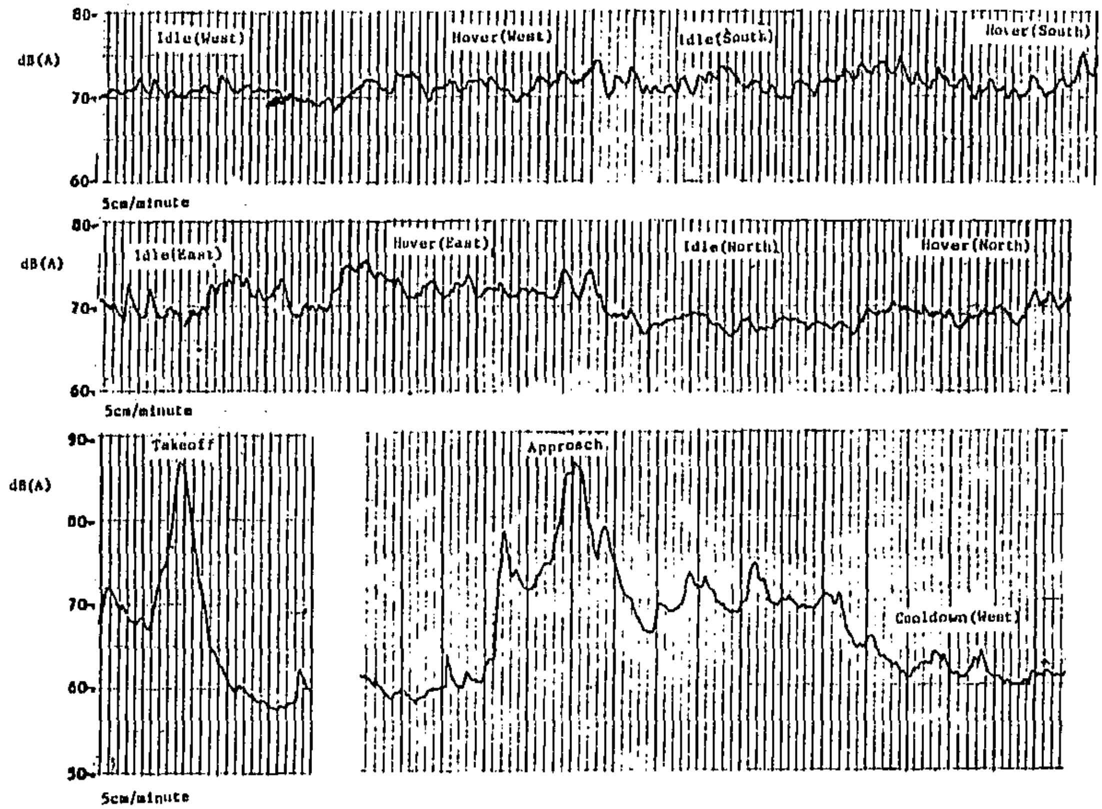


Figure 6.11 GLR Output for City of Portland Temporary Public Use Heliport Test Station 2

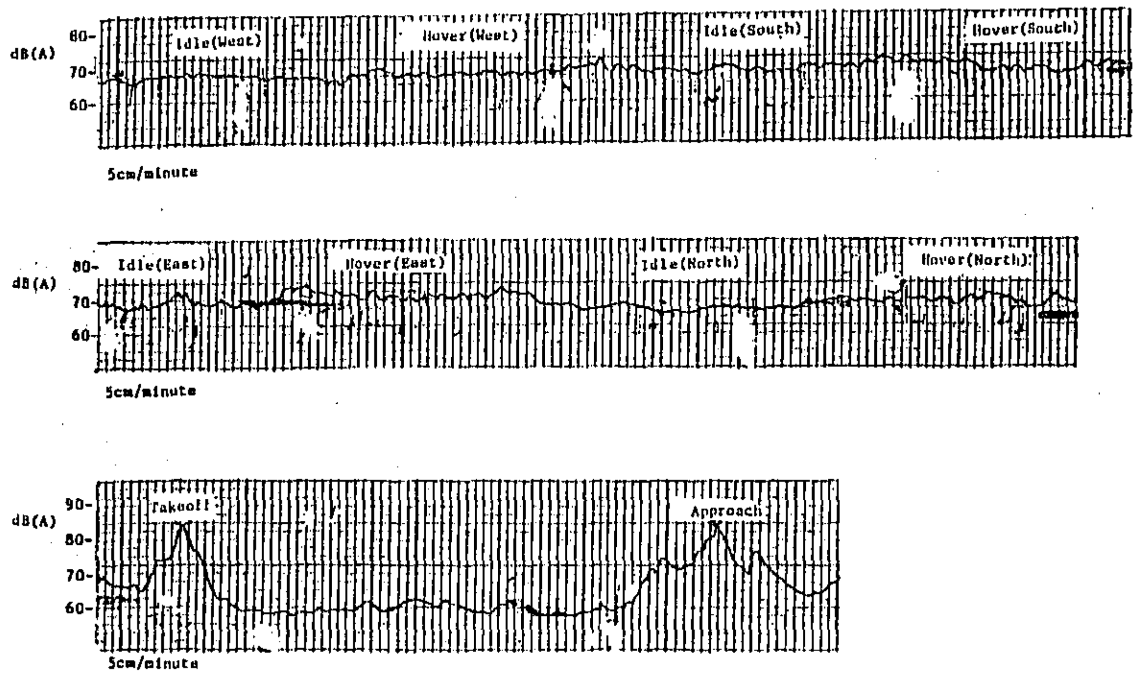


Figure 6.12 GLR Output for City of Portland Temporary Public Use Heliport Test Station 3

TABLE 6.5 AMBIENT NOISE LEVELS AT CITY OF PORTLAND TEMPORARY PUBLIC USE HELIPORT

Location: Temporary Public Use Heliport
Date: April 24, 1984
Time: 9:09 a.m.-11:27 a.m.
Helicopter Model: Bell 206B Jetranger III

Temperature: 44 F
Weather: Light drizzle and hail
Wind Speed: 0 - 3 knots from E

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient with helicopter test maneuvers.	9:09-10:09	1 Hour	85[1]	83	75	69	61	58	57	56	66	Includes 1 small helicopter, and passing truck.
Ambient without helicopter test maneuvers.	10:27-11:27	1 Hour	74[2]	-	-	-	-	58	56	55	60	Includes 10 trucks, distant jet flyover, 2 helo flyovers, tugboat, and hail on equipment.

All noise data were recorded with A-frequency weighting and slow response time averaging.
- = no valued obtained due to equipment malfunction.
[1] = Lmax recorded from test helicopter approach.
[2] = Lmax recorded from Bell 206B Jetranger III Landing.
(value obtained from graphic chart)

TABLE 6.6 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3
CITY OF PORTLAND TEMPORARY PUBLIC USE HELIPORT

Location: Temporary Public Use Heliport
Date: April 24, 1984
Time: 8:08a.m.-11:27a.m.

Temperature: 44 F
Weather: Light drizzle and rain
Wind Speed: 0 - 3 knots from E

Event	Lmax
Traffic:	
Heavy truck 75' away.	65
Heavy truck on freeway 800-1000' away.	60
Truck 75' away.	63
Dumptruck 250' away.	63
Heavy truck 250' away.	63
Heavy truck 250' away.	62
Dumptruck 250' away.	62
Dumptruck with back door banging 250' away.	73
Miscellaneous:	
Hail hitting equipment.	65
Jet overflight.	65
Tug boat on river 100' away.	64
Bell 206 helicopter overflight directly over head at 500'.	74
Helicopter overflight 200' away at 500' altitude.	63
Helicopter overflight 200' away at 500' altitude.	65
Helicopter Test Maneuvers:	
Idle(West)	69
Hover(West)	71
Idle(South)	72
Hover(South)	73
Idle(East)	71
Hover(East)	73
Idle(North)	67
Hover(North)	70
Takeoff	84
Approach	85

All noise data were recorded with A-frequency weighting and slow response time averaging.

test helicopter takeoff and approach, respectively. The highest Lmax value recorded for a non-helicopter noise source was 73dB(A) from a dump truck passing approximately 200 feet from the microphone. By comparison, a Bell 206B helicopter that passed at a lateral distance of 100 feet and an altitude of 500 feet registered a Lmax value of 74dB(A), only one dB(A) higher than the dump truck.

6.2.3 Floating Point Systems, Inc.

Floating Point Systems, Inc. has a corporate helipad in Beaverton, Oregon, three miles west of Portland (location 13 in Figures 6.2 and 6.4). Land use in the vicinity of the helipad is mainly low density detached single family residential housing. A 15 to 20 acre vacant field lies to the west and north of the helipad with residential housing across from the field to the west and north. Railroad tracks run north to south 40 feet to the west of the helipad. Two four-lane divided streets border the helipad on the east and south and contain commercial, retail, and some light manufacturing businesses. A shopping center is located 500 feet to the southeast of the helipad at the intersection of these two four-lane divided streets. Land use to the east and south of the helipad is primarily low density detached single family residential housing.

Three noise monitoring stations were set up in an array extending 150 feet, 324 feet, and 474 feet east from the helipad (shown in Figure 6.13). The helipad and the three noise monitoring stations were located on the asphalt parking lot of Floating Point Systems, Inc. The stations were positioned between two rows of parked cars. Two, two-story concrete buildings were located 150 feet to the north of the measurement array. A shopping center and a two-story warehouse were located

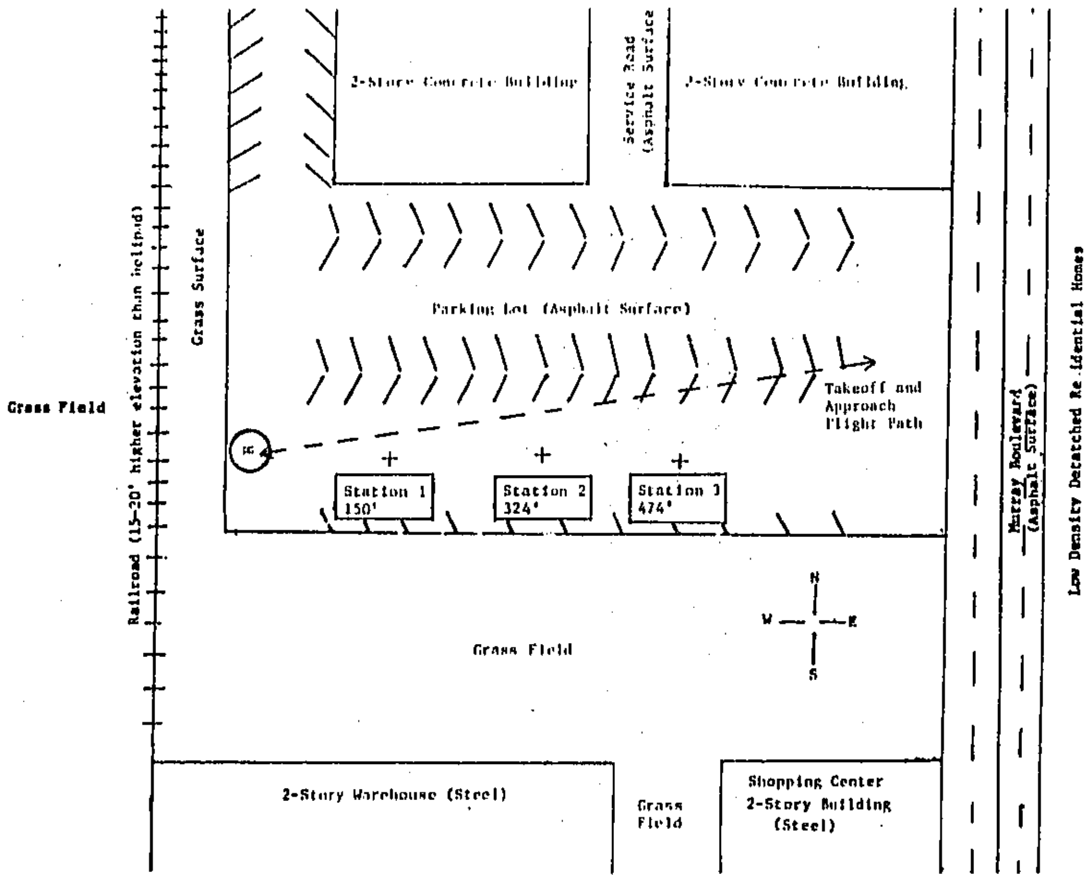


Figure 6.13 Site Schematic for Floating Point Systems, Inc. Helipad Test Site

to the south of the measurement array. Murray Boulevard runs north-south approximately 400 feet east of Station 3. An open grass field was to the west of the helipad.

Background ambient noise levels were relatively low near the helipad. Several ambient noise samples, taken between 9:00 a.m. and 11:00 a.m., showed Leq levels in the range of 45dB(A) to 50dB(A). Ambient noise samples taken at 11:30 a.m. showed an increase in Leq levels to between 58 dB(A) and 63dB(A). This was largely the result of cars leaving the parking lot during lunch time, and were the primary noticeable intrusive noise sources present during the sample periods.

The helicopter pilot at the Floating Point Systems, Inc. helipad used an Agusta A109A helicopter to perform 14 maneuvers shown below in the order in which they were performed.

1. Hover, North;
2. 100% flat pitch, idle, North;
3. 62% flat-pitch idle, North;
4. Hover, West;
5. 100% flat pitch idle, West;
6. 62% flat-pitch idle, West;
7. Hover, South;
8. 100% flat pitch idle, South;
9. 62% flat-pitch idle, South;
10. Hover, East;
11. 100% flat pitch, idle, East;
12. 62% flat-pitch idle, East;
13. Takeoff, to East;
14. Approach, from East.

Table 6.7 shows the noise levels recorded from the test maneuvers at the three measurement stations. Lmax values measured from 62% flat-pitch idle run maneuvers with the helicopter facing north and south (i.e., perpendicular to the measurement array) were 6dB(A) to 8dB(A) lower than Lmax values measured from 100% takeoff idle maneuvers in the same directions. Similarly, Lmax values measured from 62% flat-pitch idle run maneuvers with the helicopter facing east and west (i.e., parallel to the measurement array) were 10dB(A) to 13dB(A) lower than Lmax values measured from 100% flat-pitch, idle maneuvers in the same directions.

In order to avoid two tall trees, the takeoff and approach maneuvers were executed approximately 50 feet to the north of the measurement array. (For this reason, the takeoff and approach data in this series of tests are not directly comparable to other takeoff and approach data.) The takeoff maneuver was performed at a very shallow ascent rate, which may explain why the Lmax values measured at the three stations are relatively similar (less than 3dB(A) difference between Stations 1 and 3). The sound pressure level time graphs recorded at Stations 1, 2, and 3 for each maneuver are shown in Figures 6.14, 6.15, and 6.16, respectively.

Table 6.8 contains ambient noise data obtained at Station 3 during three, one-hour sample periods. The third sample period includes the helicopter test maneuvers which lasted for approximately 30 minutes; the other two do not. A CNA malfunction prevented Station 3 from collecting distributional exceedance level data for the first two sample periods. The ambient noise data indicates a significantly higher hourly Leq level in the sample period that includes the helicopter test maneuvers compared with the other two sample periods. An increase of 22 dB(A) in the hourly Leq occurred between the first sample period without the helicopter test maneuvers and the sample period with the helicopter test maneuvers. However,

TABLE 6.7 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT FLOATING POINT SYSTEMS, INC.

Location: Floating Point Systems, Inc.
Date: April 25, 1984
Time: 8:30 a.m.
Helicopter Model: Augusta A109A

Temperature: 47 F
Dew Point: 48
Wind Speed: 10-15 knots from S.W.

Station	Dist. From Pad (ft.)	Hover (North) Time (sec.)	Leq	SEL	Lmax	100% Idle (North) Time (sec.)	Leq	SEL	Lmax	62% Idle (North) Time (sec.)	Leq	SEL	Lmax	Hover (West) Time (sec.)	Leq	SEL	Lmax	100% Idle (West) Time (sec.)	Leq	SEL	Lmax
1	150	27	88.6	102.0	92.0	28	85.4	99.8	85.6	31	77.7	92.6	79.4	27	88.6	102.9	91.2	22	81.1	94.3	83.4
2	324	27	80.6	94.8	85.7	28	79.3	93.8	82.4	33	71.5	86.7	75.0	27	82.7	96.9	87.5	30	78.5	91.2	78.0
3	474				78				78				70				80				75

Station	Dist. From Pad (ft.)	62% Idle (West) Time (sec.)	Leq	SEL	Lmax	Hover (South) Time (sec.)	Leq	SEL	Lmax	100% Idle (South) Time (sec.)	Leq	SEL	Lmax	62% Idle(South) Time (sec.)	Leq	SEL	Lmax	Hover(East) Time (sec.)	Leq	SEL	Lmax
1	150	28	68.7	83.1	70.8	31	89.7	103.2	90.7	32	85.1	100.1	86.7	28	77.5	92.1	81.2	26	86.8	100.8	88.8
2	324	29	65.6	80.2	67.0	28	85.4	100.0	87.4	33	78.6	94.7	82.4	28	70.8	85.3	74.2	27	80.2	94.5	84.8
3	474				64				82				75				75[1]				83

[1] = Lmax is from car passing near microphone.
All noise data recorded with A-frequency weighting
and slow response time averaging.

(Table continued on next page)

TABLE 6.7 (continued)

Sta-tion	Dist. From Pad (ft.)	100% Idle (East)[1]				62% Idle (East)				Takeoff [2][+]				Approach[3][+]			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	150	32	81.2	96.2	82.3	35	70.4	85.8	71.8	25	90.6	104.5	98.6	37	83.5	100.1	103.4
2	324	34	76.7	91.9	78.6	36	65.1	80.6	68.3	28	88.3	102.7	97.7	38	89.1	104.8	98.8
3	474				74				84				87				85

[1]=Lmax is from car passing near microphone.
[2]=Helicoper estimated at 70' altitude directly over Station 2 (visual judgement).
[3]=Helicopter estimated at 60' altitude directly over Station 2 (visual judgement).
[+]=Noise data not directly comparable with corresponding data in other tests. See text.
All noise data recorded with A-frequency weighting and slow response time averaging.

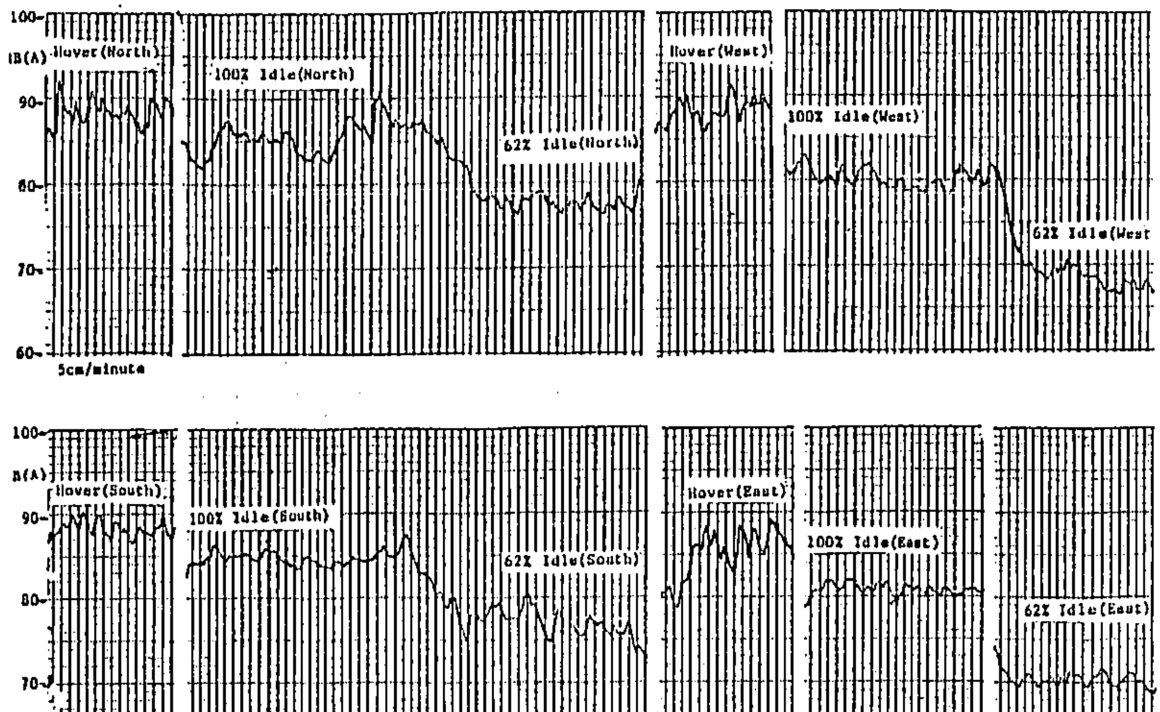


Figure 6.14 GLR Output for Floating Point Systems, Inc. Test - Station 1

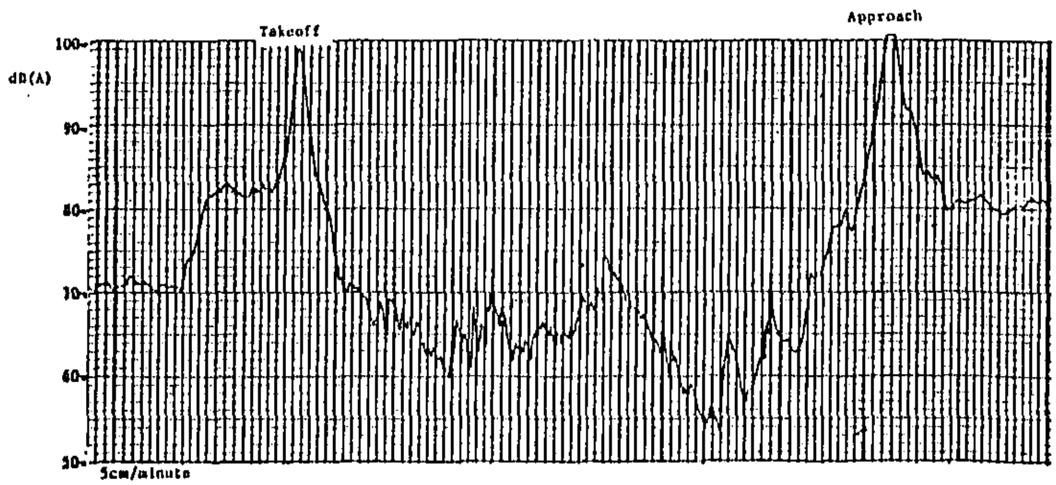


Figure 6.14 (continued)

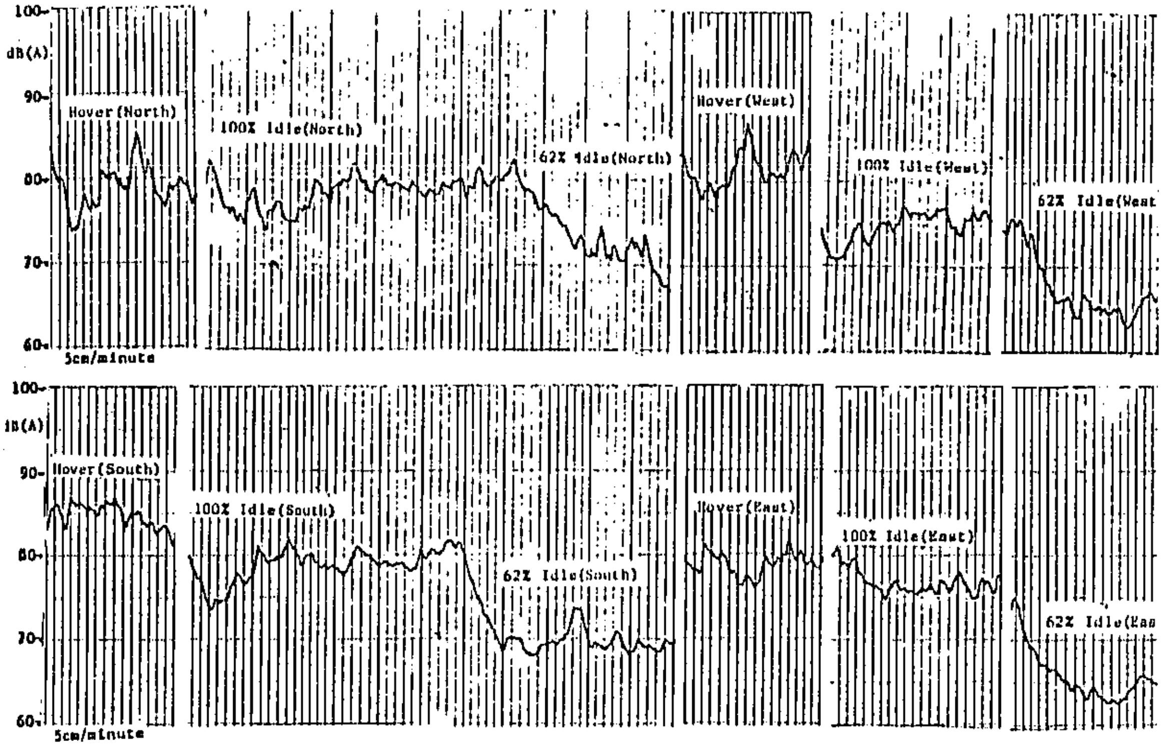


Figure 6.15 GLR Output for Floating Point Systems, Inc. Test - Station 2

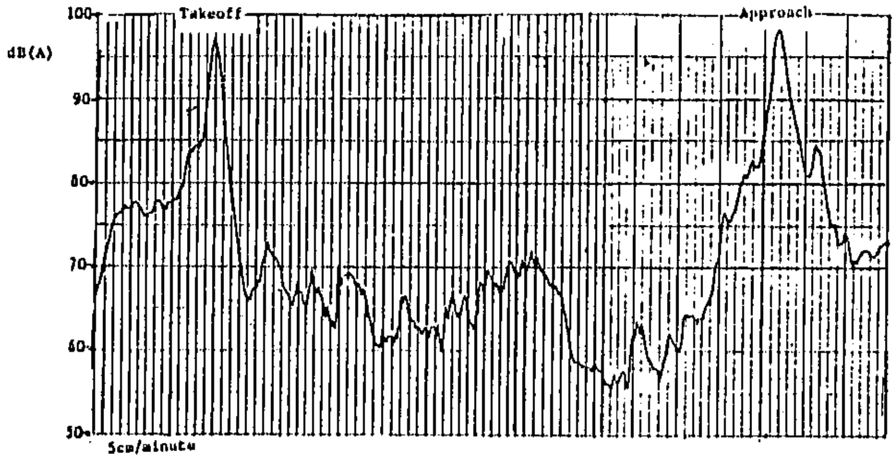


Figure 6.15 (continued)

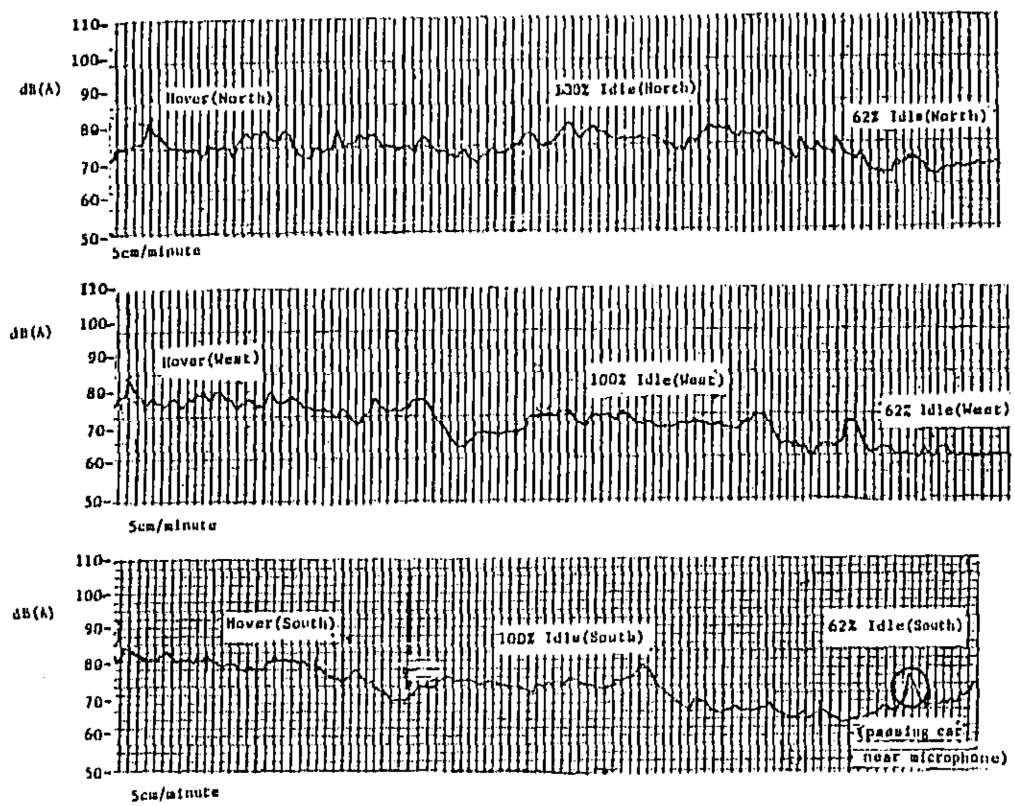
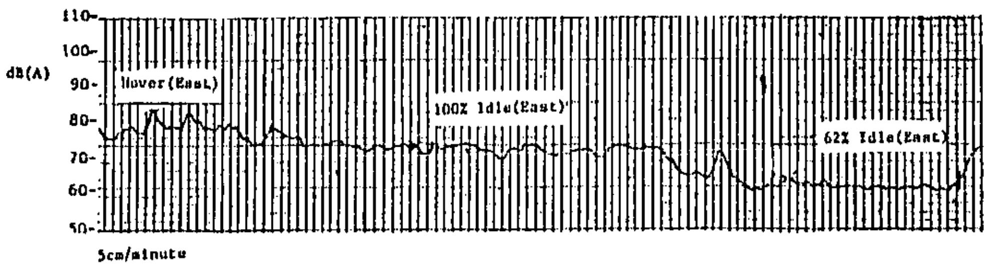


Figure 6.16 GLR Output for Floating Point Systems, Inc. Test - Station 3



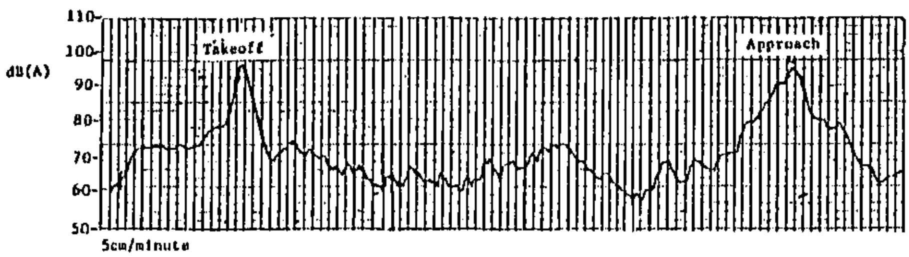


Figure 6.16 (continued)

TABLE 6.8 AMBIENT NOISE LEVELS AT FLOATING POINT SYSTEMS, INC.

Location: Floating Point Systems, Inc.
Date: April 25, 1984
Time: 9:35 a.m.-12:35 p.m.
Helicopter Model: Augusta A109A

Temperature: 47 F
Dew Point: 48
Wind Speed: 10 to 15 knots from SW

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient without helicopter test maneuvers.	9:35-10:35	1 Hour	67[1]	-	-	-	-	46	44	43	52	Includes 1 jet overflight, 5 cars nearby, bird chirping.
Ambient without helicopter test maneuvers.	10:35-11:35	1 Hour	81[2]	-	-	-	-	-	45	44	61	Includes 1 helo flyby, 1 helo approach, 1 jet overflight, 3 cars near station, wind gust.
Ambient with helicopter test maneuvers.	11:35-12:35	1 Hour	87[3]	86	82	77	64	50	47	46	74	Includes several passing cars in parking lot.

All data were recorded with A-frequency weighting and slow response time averaging.
- = no valued obtained due to equipment malfunction.
[1] = Lmax recorded from large jet flyover. Value obtained from graphic chart.
[2] = Lmax from test helicopter approach to pad before test. Value obtained from graphic chart.
[3] = Lmax from test helicopter takeoff.

the sample period with the helicopter test maneuvers also included more automobile activity than the other two sample periods. Due to this increase in automobile traffic, it is difficult to estimate the exact contribution of the helicopter test maneuvers to the ambient background noise levels.

Table 6.9 shows maximum sound levels of both non-helicopter noise events and the helicopter test maneuvers, recorded during the ambient noise samples at Station 3. Intrusive noise sources were primarily cars in the parking lot. Lmax values measured from the cars ranged from 54dB(A) to 71dB(A). By comparison, the helicopter maneuvers produced Lmax values ranging from 64dB(A) for a 62% flat-pitch, idle maneuver to 97dB(A) for a takeoff maneuver. Noise levels produced from 62% flat-pitch, idle maneuvers appear to be within the range of noise levels typically encountered in the neighborhood of the helipad. Lmax values from 100% takeoff idle and hover maneuvers are from 3dB(A) to 12dB(A) higher than the highest Lmax value measured from non-helicopter events at the helipad.

6.2.4 KATU Television

The helipad at KATU Television is located on the roof of the three-story television station building approximately 45 feet above the street (location 3 in Figures 6.1 and 6.3). Land use in the neighborhood of the helipad is primarily commercial and retail businesses, and apartment buildings. Land use to the northwest and west is primarily commercial, retail, and light manufacturing businesses. Land use to the south, east and north is medium density multi-family and detached single family housing with small areas of commercial and retail businesses on major streets. A small park and a high school are located seven blocks to the west of the helipad. A four-lane divided street, N.E. Sandy Boulevard, with moderate to heavy automobile and truck traffic is located two blocks south of the helipad.

TABLE 6.9 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3
FLOATING POINT SYSTEMS, INC.

Location: Floating Point Systems, Inc.
Date: April 24, 1984
Time: 9:08a.m.-11:27a.m.

Temperature: 47 F
Dew Point: 48
Wind Speed: 10-15 knots from S.W.

Event	Lmax
Traffic:	
Car in parking lot 15' away.	54
Car in parking lot 5' away.	58
Same as above.	63
Same as above.	60
Same as above.	67
Same as above.	65
Same as above.	71
Aircraft Activity:	
Overhead jet.	66
One prop. Cessna overhead.	64
Miscellaneous:	
Bird chirping 10' away.	59
Bird chirping.	63
Strong gust of wind.	67
Helicopter test maneuvers:	
Hover(North)	78
100% Idle(North)	78
62% Idle(North)	70
Hover(West)	80
100% Idle(West)	75
62% Idle(West)	64
Hover(South)	82
100% Idle(South)	75
62% Idle(South) (includes car)	75
Hover(East)	83
100% Idle(East)	74
62% Idle(East)	64
Takeoff	97
Approach	95

All noise data were recorded with A-frequency weighting and slow response time averaging.

Three noise monitoring stations were set up in an array extending 150 feet, 300 feet, and 500 feet northwest from the helipad Figure 6.17 shows a site schematic of the three noise monitoring station locations in relation to the helipad as well as the flight paths used for takeoff and approach maneuvers. Stations 1 and 2 were located on the asphalt parking lot of the television station. Station 3 was located on a concrete sidewalk next to a two-story stucco apartment building. Background ambient noise levels were relatively low near Stations 1 and 2, with Leq levels in the mid to high 50dB(A) range. Heavy trucks on N.E. 21st Avenue, near Station 3, passed near the microphone. This resulted in Leq values in the low to mid 60dB(A) range near Station 3.

The helicopter pilot performed 14 maneuvers with a Hughes 500D helicopter (with modified four-bladed tail rotor). The maneuvers are shown below in the order in which they were performed:

1. 100% flat pitch, idle, West;
2. Hover, West;
3. Hover, South;
4. 100% flat pitch, idle, South;
5. 62% flat pitch, idle, South;
6. Hover, East;
7. 100% flat pitch, idle, East;
8. 62% flat pitch, idle, East;
9. Hover, North;
10. 100% flat pitch, idle, North;
11. 62% flat pitch, idle, North;
12. T.O., to North;
13. Approach, from North;
14. Engine cool down, West.

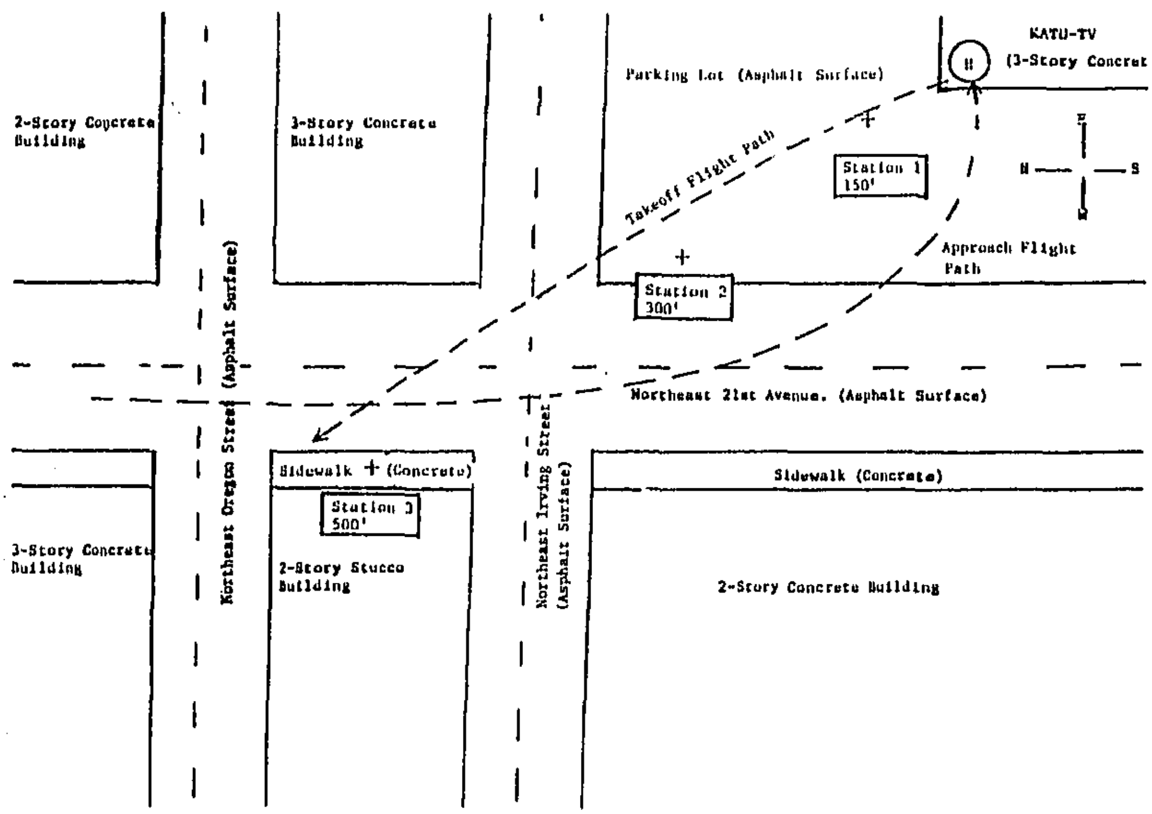


Figure 6.17 Site Schematic for KATU Television Helipad Test Site

Table 6.10 shows the noise levels recorded from the helicopter test maneuvers at the three measurement stations. The 100% takeoff idle maneuvers registered Lmax values 9dB(A) to 11dB(A) higher than the 62% ground idle maneuvers.

On the takeoff maneuver the helicopter flew directly over Station 1 and 40 to 50 feet northeast of Stations 2 and 3 the to avoid flying directly over an apartment building. (For this reason, the takeoff data in this series of test are not directly comparable to other takeoff data.) The helicopter maintained a shallow ascent rate as it passed near Stations 2 and 3. This may account for the similar Lmax values recorded for the takeoff maneuver at these stations. The approach maneuver was executed with a relatively steep descent angle. The helicopter approached along N.E. 21st Avenue between Stations 2 and 3 and turned east in front of Station 1 for landing. The helicopter passed slightly closer to Station 3 than to Station 2. This accounts for the Lmax value measured at Station 3 being almost 2dB(A) higher than that measured at Station 2. The helicopter, as it passed near Station 2 was at an altitude approximately 120 feet higher on the takeoff than on the approach. This explains the lower Lmax values recorded for the takeoff maneuver as compared to the approach maneuver. The sound pressure level time graphs recorded at Stations 1, 2, and 3 for each maneuver are shown in Figures 6.18, 6.19, and 6.20, respectively.

Table 6.11 presents the noise data obtained from three, one-hour ambient noise sample periods recorded at Station 3. The first ambient noise sample period does not include the helicopter test maneuvers; the second ambient noise sample period includes all of the helicopter test maneuvers which lasted approximately 22 minutes. The third ambient noise sample includes the test helicopter warming up and a takeoff to the east which lasted

TABLE 6.10 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT KATU-TV

Location: KATU-TV
Date: April 26, 1984
Time: 9:00 a.m.
Helicopter Model: Hughes 500D (with modified tail rotor)

Temperature: 49 F
Dew Point: 38
Wind Speed: 0 - 3 knots

Station	Dist. From Pad (ft.)	100% Idle (West)				Hover (West)				Hover (South)				100% Idle(South)				62% Idle (South)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	150	24	79.0	92.6	79.0	27	83.4	97.7	84.6	28	85.4	99.9	87.3	33	77.6	92.7	78.8	26	68.7	82.9	69.5
2	300	25	75.3	89.2	76.4	27	80.7	94.8	83.2	28	82.8	97.2	85.9	33	72.9	88.1	74.6	27	63.9	78.1	64.9
3	500				76				81				82				73				63

Station	Dist. From Pad (ft.)	Hover (East)				100% Idle (East)				62% Idle (East)				Hover (North)				100% Idle (North)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	150	20	84.5	98.1	86.6	33	77.1	92.2	78.8	31	68.8	83.8	69.9	36	81.0	96.5	83.4	33	73.0	88.1	76.2
2	300	26	70.1	83.5	70.6	33	75.1	88.7	78.1	31	65.0	79.9	66.7	36	77.4	93.1	78.8	34	71.6	86.9	74.0
3	500				*				72				*				70				67

All noise data recorded with A-frequency weighting
and slow response time averaging.
* = Not able to detect maneuver because of high
ambient background noise.

(Table continued on next page)

TABLE 6.10 (continued)

Sta-tion	Dist. From Pad (ft.)	62% Idle (North) Time (sec.)	Leq	SEL	Lmax	Takeoff [1][+] Time (sec.)	Leq	SEL	Lmax	Approach [2] Time (sec.)	Leq	SEL	Lmax	Cooldown (West) Time (sec.)	Leq	SEL	Lmax
1	150	31	62.8	77.7	64.3	22	83.8	96.8	89.4	16	89.2	101.2	95.0	72	63.5	82.0	65.2
2	300	38	61.1	76.8	62.8	24	79.5	93.3	83.7	26	81.1	95.2	88.2	68	61.5	79.8	67.8
3	500				60				83				88				*

All noise data recorded with A-frequency weighting and slow response time averaging.

* = Not able to detect maneuver because of high ambient background noise.

[1] = Helicopter estimated at 215 feet altitude as it passed near Station 2 (photo scaling).

[2] = Helicopter estimated at 135 feet altitude as it passed near Station 2 (photo scaling).

[+] = Noise data not directly comparable with corresponding data in other tests. See text.

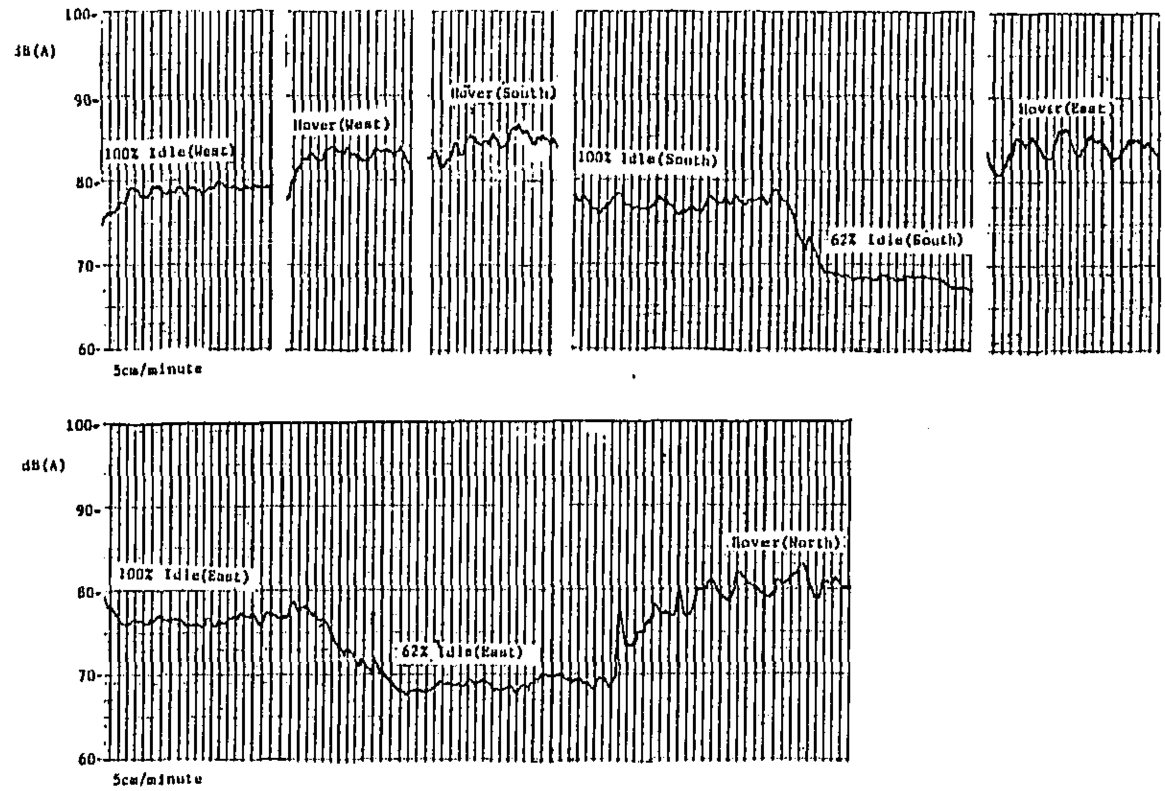


Figure 6.18 GLR Output for KATU-TV Test - Station 1

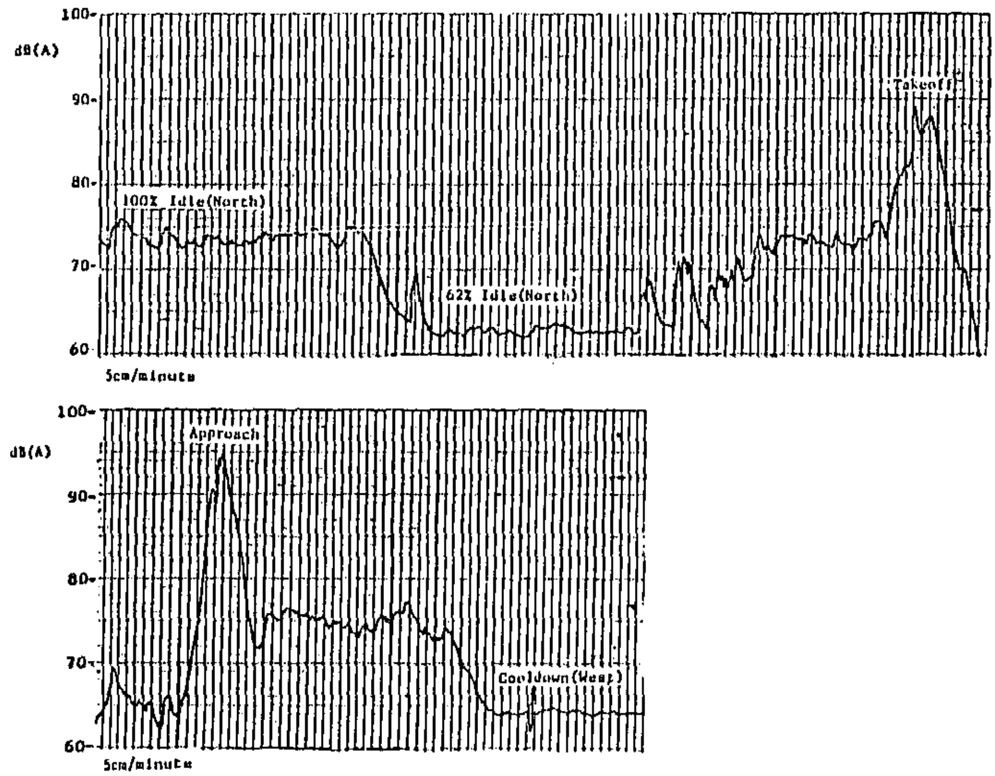


Figure 6.18 (continued)

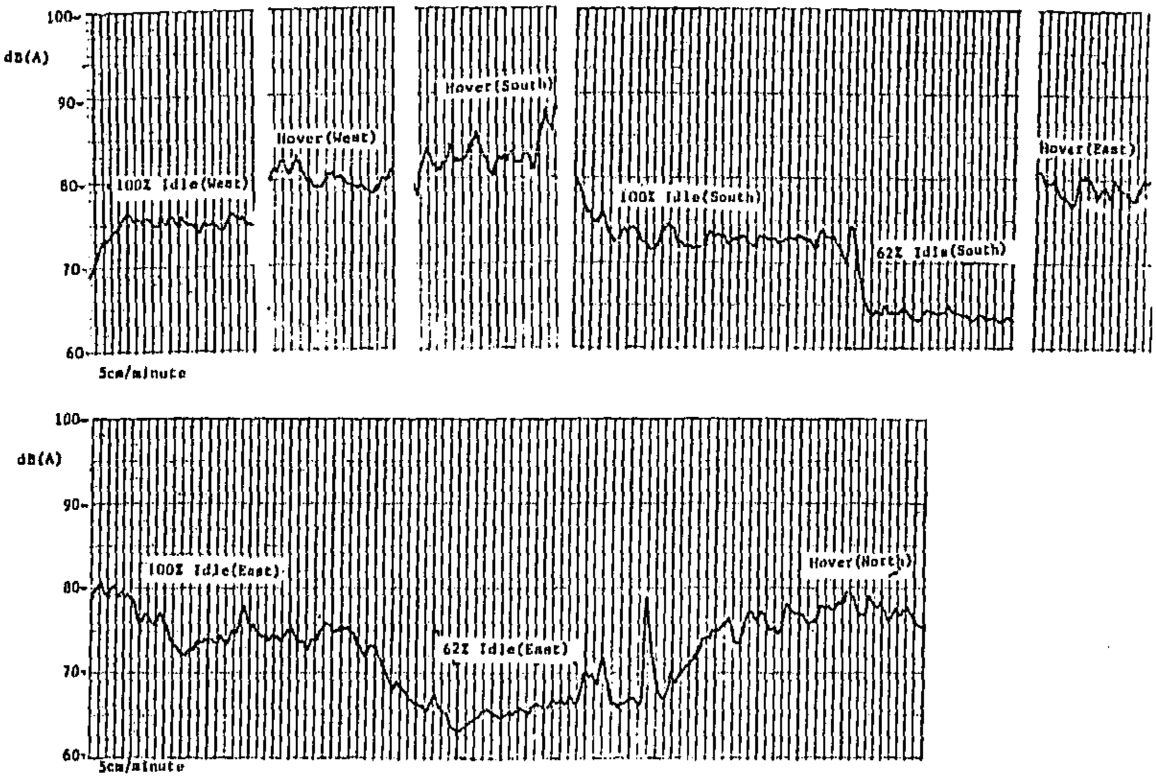


Figure 6.19 GLR Output for KATU-TV Test - Station 2

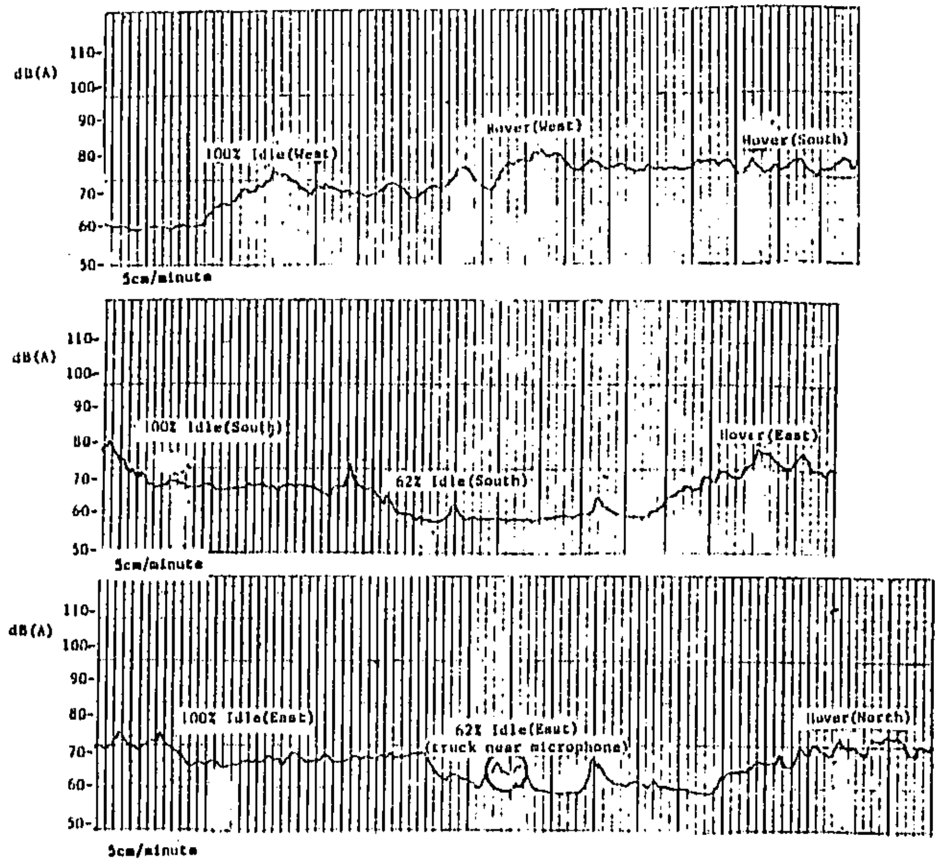
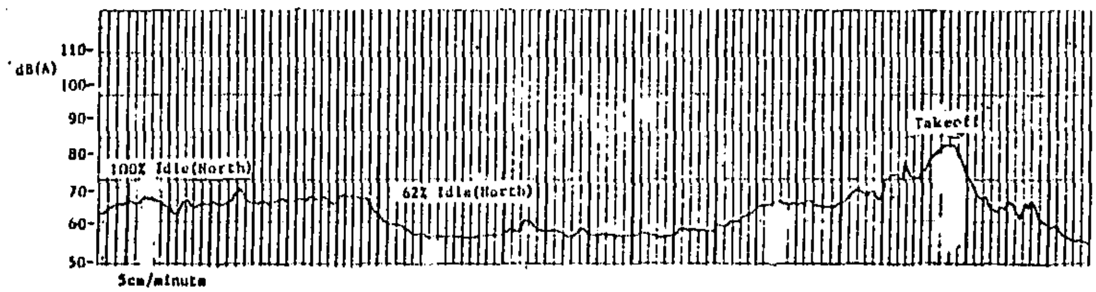


Figure 6.20 GLR Output for KATU-TV Test - Station 3



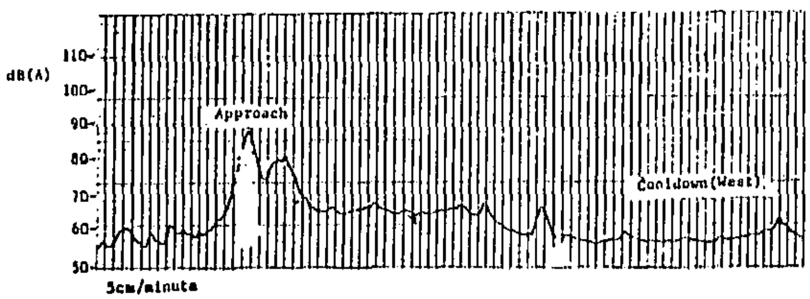


Figure 6.20 (continued)

TABLE 6.11 AMBIENT NOISE LEVELS AT KATU-TV

Location: KATU-TV
Date: April 28, 1984
Time: 8:11 a.m.-11:37a.m.
Helicopter Model: Hughes 500D (with modified four bladed tail rotor)

Temperature: 49 F
Dew Point: 38
Wind Speed: 0 - 3 knots

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient without helicopter test maneuvers.	8:11-9:11	1 Hour	82[1]	-	-	-	-	52	49	48	63	Includes moderate automobile traffic, semi-truck passed 5' from station, 2 semi-trucks stopped 10' from station with engine running for 5 minutes.
Ambient with helicopter test maneuvers.	9:17-10:17	1 Hour	88[2]	-	-	-	-	-	51	49	68	Includes truck 55' away, semi-trailer 5' away, light automobile traffic.
Ambient without helicopter test maneuvers.	10:38-11:38	1 Hour	84[3]	-	-	-	-	52	48	47	64	Includes test helicopter warm-up and takeoff perpendicular to array, semi-truck 5' away, and light automobile traffic.

All data were recorded with A-frequency weighting and slow response time averaging.
- = no valued obtained due to equipment malfunction.
[1] = Lmax recorded from heavy truck 15' from microphone. Value obtained from graphic chart.
[2] = Lmax recorded from test helicopter approach. Value obtained from graphic chart.
[3] = Lmax value from heavy truck 6' away.

approximatly three minutes. The Leq level measured during the sample period with the helicopter test maneuvers is 5dB(A) higher than the sample period without the helicopter test maneuvers, and 4dB(A) higher than the sample period that includes a helicopter warm-up and takeoff.

Table 6.12 shows Lmax values of selected non-helicopter noise events and the helicopter test maneuvers recorded at Station 3. Several heavy trucks that passed near the microphone produced Lmax values in the mid to upper 80dB(A) range. The highest Lmax value recorded from a non-helicopter noise source was produced by a heavy truck five feet from the microphone that registered 88dB(A). By comparison, Lmax values from the helicopter test maneuvers ranged from 59dB(A) for a 62% flat-pitch idle facing north to 83dB(A) for the takeoff maneuver measured at Station 3.

6.3 ACTUAL IN-SERVICE HELICOPTER OPERATIONS

Noise levels from several actual in-service helicopter operations were measured from the noise monitoring stations used for the standardized maneuver tests at the four helipad test sites. After the standardized maneuver tests were completed at each helipad, some of the noise monitoring stations were kept in place to obtain additional noise level data produced from actual in-service helicopter operations occurring near the helipads. Many of the in-service operations which were measured involved the helicopter used in the standardized maneuver tests.

Table 6.13 shows the noise level data obtained from the actual in-service operations monitored at these stations. The highest Lmax value (88dB(A)) was registered by an Agusta A109A helicopter landing 150 feet away. The highest Lmax value recorded from a level flight operation, 80 dB(A), was obtained

TABLE 6.12 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3 KATU-TV

Location: KATU-TV (Station 3)
Date: April 26, 1984
Time: 8:11 a.m.-11:37 a.m.

Temperature: 49 F
Dew Point: 38
Wind Speed: 0 - 3 knots

Event

Traffic:	Lmax
Dump truck 3/4 blocks away.	78
Heavy truck with trailer 5' away.	82
Two heavy trucks with trailers 10' away.	80
Car 15' away.	85
Same as above.	84
Same as above.	89
Same as above.	88
Same as above.	83
Same as above.	89
Same as above.	89
Same as above.	84
Truck 15' away.	75
Truck 5' away.	84
Heavy truck with trailer 5' away.	85
Heavy truck with trailer 40' away.	81
Truck horn 1 block away.	80
Van 5' away.	88
Heavy truck with trailer 5' away.	87
Car 5' away.	71
Car 15' away.	85
Same as above.	84
Same as above.	86
Same as above.	82
Heavy truck with trailer 5' away.	87
Aircraft traffic:	
Helicopter takeoff to west from test pad.	78
Helicopter warmup at takeoff idle facing west.	71

	Lmax
Large car starting 15' away.	81
Helicopter test maneuvers:	
100% Idle(West)	75
Hover(West)	81
Hover(South)	82
100% Idle(South)	73
62% Idle(South)	63
Hover(East)	79
100% Idle(East)	72
Hover(North)	76
100% Idle(North)	67
62% Idle(North)	59
Takeoff	83
Approach	88
Cooldown(West)	59

All noise data were recorded with A-frequency weighting and slow response time averaging.

TABLE 6.13 NOISE DATA FOR ACTUAL IN-SERVICE HELICOPTER OPERATIONS MONITORED HELIPAD TEST SITES

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Messerschmitt BO 105 flyover northeast to southwest 700' away.	1 (Station 2)	300	5	57.1	64.1	58.8
Messerschmitt BO105 approach from south 227 ft. away.	1 (Station 2)	75 (at touchdown)	41	75.1	91.2	80.5
Same as above, 372 ft. away.	1 (Station 2)	75 (at touchdown)	14	75.4	64.6	77.4
Same as above, 516 ft. away.	1 (Station 3)	75 (at touchdown)	(1)	(1)	(1)	72
Small helicopter flyover from south to north 800' away.	2 (Station 3)	500	(1)	(1)	(1)	68
Bell 206B approach from south to north and landed 435' away.	2 (Station 3)	10	(1)	(1)	(1)	82
Medium size helo flyover east to west overhead.	2 (Station 3)	500	(1)	(1)	(1)	74
Medium size helo flyover 800' away.	2 (Station 3)	500	(1)	(1)	(1)	65
Bell 206B landing 435 ft. away from east to west.	2 (Station 3)	10	(1)	(1)	(1)	74
Bell 206B flyover south to north 700 ft. away.	2 (Station 3)	500	(1)	(1)	(1)	61
Same as above, 185 ft. away.	2 (Station 3)	300	(1)	(1)	(1)	65
Bell 206B north to south 800' away.	13 (Station 1)	500	15	55.8	67.5	59.6

All noise data recorded with A-frequency weighting and slow response time averaging.

* See Figures 6.1 and 6.2 for station locations.

(1) Noise levels measured with the CNA which is not capable of recording measurement duration, Leq, and SEL for single-event.

(continued on next page)

TABLE 6.13 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Agusta A109A approach and landing 150 ft. away.	13 (Station 1)	40	20	83.8	96.8	88.1
Same as above, 324 ft. away.	13 (Station 2)	40	28	79.0	93.4	83.1
Agusta A109A flyover 300' away.	13 (Station 1)	300	11	77.4	87.8	80.2
Same as above.	13 (Station 2)	300	20	75.6	88.5	80.8
Agusta A109A hovering facing west 600' away.	13 (Station 1)	300	21	62.7	75.9	69.1
Agusta A109A hovering facing west 400 ft. away.	13 (Station 1)	30	28	71.7	86.1	77.9
Agusta A109A approach from north to south and landed 150 ft. away.	13 (Station 1)	40	29	84.8	99.2	88.2
Same as above, 324 ft. away.	13 (Station 2)	40	51	78.9	96.3	83.6
Hughes 500D takeoff to east 500' away.	3 (Staton 3)	50	[1]	[1]	[1]	78
Hughes 500D warmup 500 ft. away.	3 (Station 3)	N/A	[1]	[1]	[1]	60
Hughes 500D 100% takeoff idle 500' away.	3 (Station 3)	N/A	[1]	[1]	[1]	71
Hughes 500D flyover from west to east.	3 (Station 3)	150	[1]	[1]	[1]	74
Hughes 500D approach 500 ft. away west to east.	3 (Station 3)	150	[1]	[1]	[1]	80

All noise data recorded with A-frequency weighting and slow response time averaging.

* See Figures 6.1 and 6.2 for station locations.

[1] Noise levels measured with CNA which is not capable of recording measurement duration, Leq, and SEL for single-event.

(continued next page)

TABLE 6.13 (continued)

Event Description	Location	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Same as above.	3 (Station 2)	150	30	73.6	88.3	84.8
Hughes 500D flyover 300 ft. away.	3 (Station 2)	500	11	61.0	71.4	83.5
Same as above.	3 (Station 2)	500	8	60.9	69.9	83.8
Hughes 500D flyover east to west 800' away.	3 (Station 1)	500	8	60.9	69.9	83.8
Hughes 500D flyover south to north 800 ft. away.	3 (Station 1)	500	7	66.8	75.4	69.8

All noise data recorded with A-frequency weighting from the same Agusta A109A helicopter measured approximately 300 feet away and flying at an altitude of approximately 300 feet. Most of the helicopter level flight operations in Portland operate at an altitude of 500 feet. Lmax values measured from helicopter level flight operations at 500 feet altitude ranged from 60dB(A) for a Bell 206B flying 800 feet away to 74dB(A) for a medium size helicopter flying directly overhead. These Lmax values measured during level flight operations appear to be well within the range of Lmax values reported for non-helicopter urban noise sources such as heavy trucks, buses and automobile traffic.

CHAPTER 7

RESULTS OF THE HELICOPTER NOISE SURVEY IN CHICAGO, ILLINOIS

This chapter presents the results of the helicopter noise survey performed in Chicago, Illinois. The chapter is divided into four sections: Section 7.1 presents a general overview of helicopter operations in Chicago; Section 7.2 presents the noise measurement data obtained from standardized helicopter maneuvers and land use characteristics at four helipad test sites; Section 7.3 presents noise measurement data recorded from enroute helicopter operations at the public use helipads at Meigs Field Airport, and Section 7.4 presents noise measurement data recorded from actual in-service helicopter operations in Chicago.

7.1 OVERVIEW OF HELICOPTER OPERATIONS

Presently, the frequency of civilian helicopter operations in the Chicago metropolitan area is fairly moderate with a total of between 20 and 30 operations per day. There has been no pronounced adverse community reaction to noise generated from these helicopter operations, an average of fewer than three helicopter-related noise complaints per month. [Source: FAA Chicago Regional Office].

There are currently no mandatory helicopter noise abatement regulations governing helicopter operations in the city. However, the Illinois Department of Transportation has adopted some of the helicopter noise abatement operational procedures published by the Helicopter Association International as guidelines to be used by helicopter pilots operating in the state. [Source: 1984 - 85 Illinois Airport Directory, Illinois Department of Transportation, pp. 153 - 154.]. These include:

- Following high ambient noise routes (highways, railroads, etc.);
- Following unpopulated routes (waterways, etc.);
- Maintaining altitude (1000 ft.) where possible;
- Reducing speed;
- Observing low noise speed/descent settings;
- Avoiding sharp maneuvers;
- Varying flight routes; and
- Using steep takeoff/descent profiles.

According to information obtained from helicopter operators and airport and city officials, there are currently 14 helipads located in the Chicago metropolitan area. Eight of the helipads are located in the downtown Central Business District (CBD), four in the southern part of the city, and two in the northern part of the city. Figure 7.1 shows the street map locations of these helipads. Noise measurements were obtained for standardized helicopter maneuvers at locations 1 through 4.

The eight helipads located in the CBD include one at the Continental Bank corporate office, one at Cook County Hospital, two at Chicago Fire Department locations, and four public use helipads at Meigs Field Airport.

The Continental Bank helipad is at street level and is used mainly for transporting bank executive personnel. Occasionally it is used by non-bank helicopter operators transporting executives to and from the CBD. The number of operations at this helipad averages between two and three per day. The helipad is at the intersection of two large downtown streets adjacent to railroad tracks. Other land use in the vicinity consists of commercial and light manufacturing businesses.

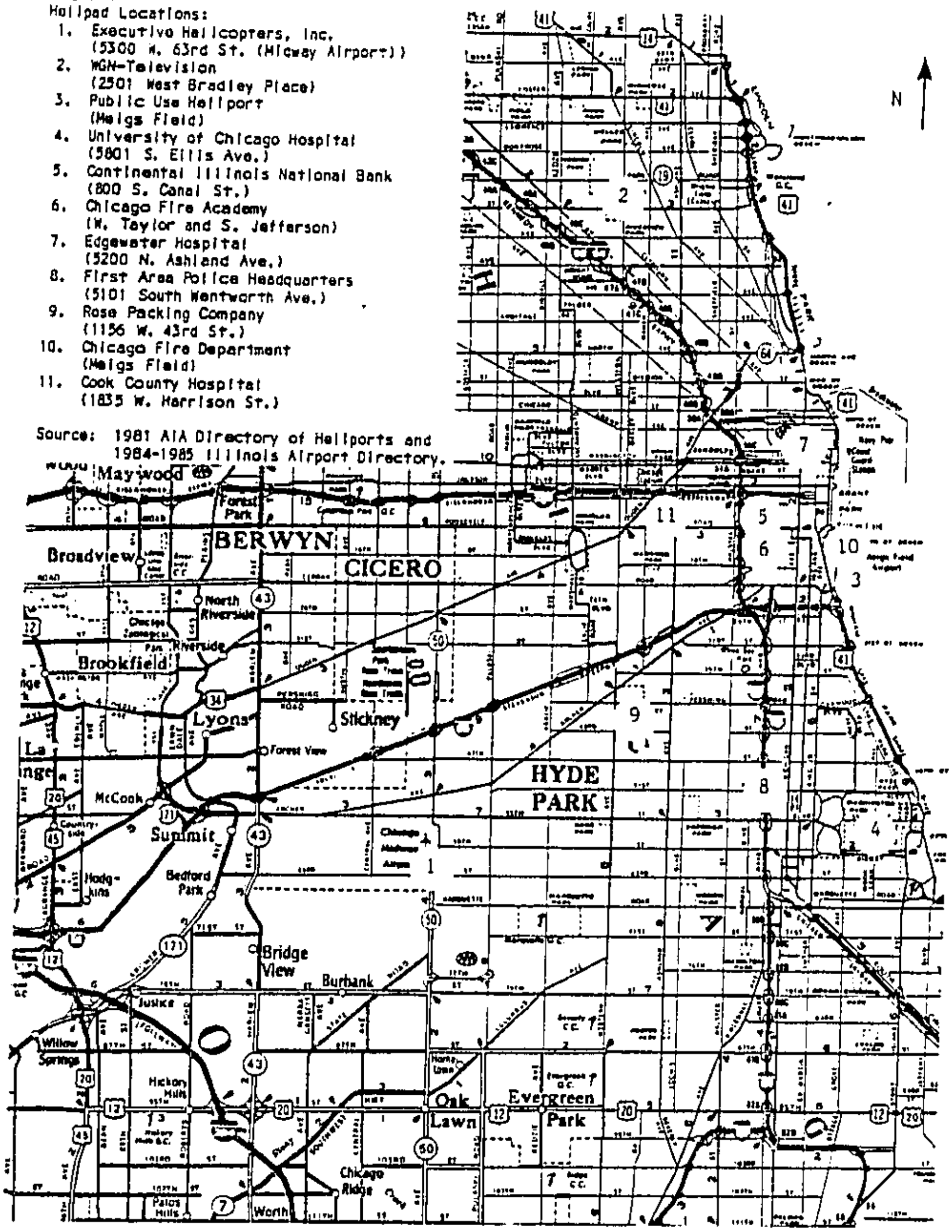


Figure 7.1 Locations of Helipads in Chicago

The Cook County Hospital, located in the western portion of the CBD, has a street level helipad used for emergency helicopter operations to and from the hospital. These operations average approximately one per day. The helipad is bordered by Interstate 290 to the north and three hospitals to the west. Land use to the south and east of the helipad is primarily residential housing with some commercial and retail businesses along two major streets.

The Chicago Fire Department operates one helipad at Meigs Field and one downtown at the Chicago Fire Academy. Operations at these helipads generally consist of search and rescue missions, training and emergency fire-fighting activities. Due to the emergency nature of these operations, their frequency varies widely, but generally averages around two operations per day at each helipad. Land use around the Meigs Field helipad consists of Lake Michigan to the east, park land to the north and south and high density commercial, retail, and light manufacturing businesses to the northwest, west, and southwest. The downtown Fire Department helipad is located adjacent to a large railroad transfer yard to its east. Land use to the north, west, and south of the downtown helipad consists primarily of light manufacturing, commercial and retail businesses.

At Meigs Field, in addition to the Chicago Fire Department helipad, there are four public use helipads that are used by several local helicopter companies as well as for transient helicopter operations. Crescent Helicopter operates on-call passenger helicopter service between Meigs Field and O'Hare International Airport, Midway Airport, DuPage Airport, Gary Municipal Airport, and the Schaumburg Marriott Hotel. A local TV station also uses Meigs field as a base for its helicopter operations. The number of operations at the Meigs Field helipads range between five and ten per day.

The four helipads located in the southern part of the city are operated by a privately owned helicopter company, a corporate office, a police station, and a hospital. Executive Helicopter, Inc. operates a helipad and helicopter maintenance facility at Midway Airport. Operations involve pilot training, FAR 135 charter services, photography, and transportation of executive personnel. The company also leases helicopters to the WGN television station and the University of Chicago Hospital. The number of operations at the Midway Airport helipad averages between four and five per day. Land use to the north, west, and east of Midway Airport is primarily residential housing; land use to the south consists primarily of heavy industry, including a large railroad yard.

The Rose Packing Company operates a private corporate helipad used primarily for transporting company's executives to and from its facilities in Barrington, Illinois. Although the number of daily operations varies, it generally averages only three to four per week. The helipad is located adjacent to a major railway line in a primarily heavy industrial zone.

The Chicago First Area Police Headquarters has a helipad in South Chicago used primarily for emergency operations and traffic monitoring. The helipad is sandwiched between a major interstate highway and a major railway line.

The University of Chicago Hospital helipad is located on the roof of the seven-story hospital. Helicopter operations at the hospital consist of emergency ambulance service and transporting patients between area hospitals. The frequency of operations averages approximately two per day. Land use around the hospital helipad is primarily single family residential housing with two large parks nearby.

The two helipads in the northern part of the city are operated by WGN-Television and Edgewater Hospital, respectively. The WGN helipad is in the parking lot of the television studio building. Operations at the helipad consist of traffic monitoring and news reporting. The frequency of operations averages approximately four per day. Land use in the vicinity is zoned primarily light manufacturing businesses and residential. A large technical school is located two blocks to the south of the helipad across from a busy street.

The Edgewater Hospital maintains a street level helipad at the hospital which it uses for emergency ambulance operations. The number of helicopter operations averages about two per day. Land use in the vicinity of the helipad is primarily residential.

7.2 STANDARDIZED MANEUVER TESTS

Four helicopter models were tested in Chicago: a Bell 206B, a Hughes 500D, an Aerospatiale Twinstar, and a Enstrom F28. Manufacturers' specifications for these helicopters are shown in Appendix B. Noise monitoring stations were set up to measure noise levels resulting from standardized helicopter test maneuvers at four helipads: Executive Helicopter, Inc. (location 1 in Figure 7.1), WGN Television Station (location 2), Meigs Field (location 3), and the University of Chicago Hospital (location 4). Sections 7.2.1 through 7.2.4 describe the land use, the locations of the noise monitoring stations, the helicopter test maneuvers performed, and the noise measurement data obtained at each of these helipads.

7.2.1 Executive Helicopter, Inc.

Executive Helicopter, Inc. is a privately owned helicopter company based at Midway Airport. It operates a helipad and helicopter maintenance facility located on the southern perimeter of the airport (location 1 in Figure 7.1). Land use around the helipad is indicated in Figure 7.2. It is primarily single family residential housing to the north, east, and west. The area south of the helipad is a heavy industrial zone. Commercial, retail, and light manufacturing businesses line the streets bordering the airport on all four sides.

The helipad is located on the airport's south taxiway. Three noise monitoring stations were set up on a grassy surface on a line running west from the helipad, parallel to the taxiway, at distances of 145 feet, 295 feet and 445 feet from the helipad, respectively. (We were not permitted to place the stations on the taxiway, in line with the helipad.) A diagram indicating the locations of the noise monitoring stations relative to the helipad and the flight paths used by the helicopters on approach and takeoff maneuvers is shown in Figure 7.3.

The south taxiway was closed at the time of the tests due to construction. This reduced the amount of aircraft traffic passing directly by the monitoring stations and thereby reduced the level of background noise which would otherwise have been present at the monitoring locations. However, there were several aircraft operations on nearby runways during the day, mostly Boeing 727 passenger jet takeoffs and landings. Ambient noise samples taken showed Leq levels at the airport between 68 dB(A) and 79 dB(A).

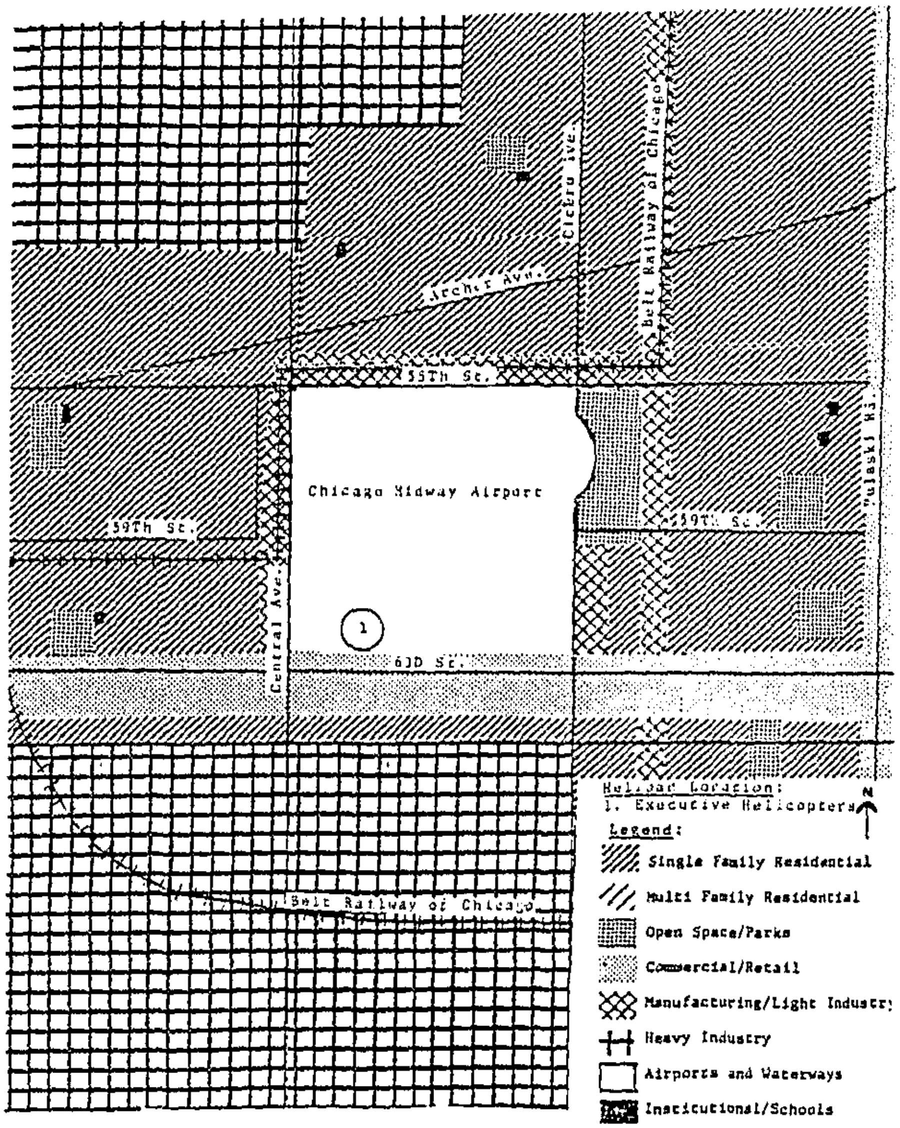


Figure 7.2 Land Use in the Vicinity of the Executive Helicopter, Inc. Helipad

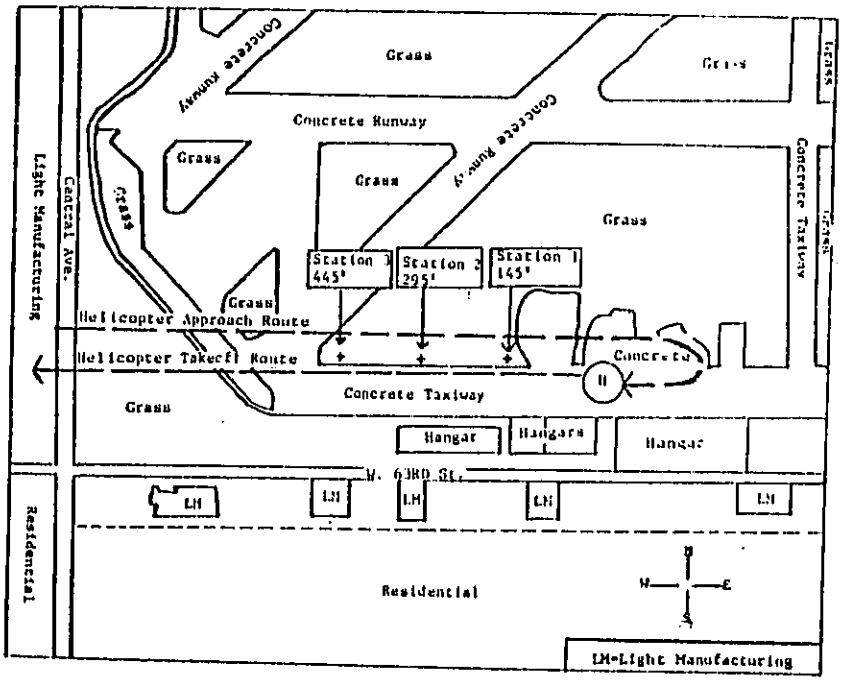


Figure 7.3 Site Schematic for Executive Helicopter Test Site

The helicopter pilot at Executive Helicopter, using a Bell 206, performed the following ten maneuvers in the order listed:

1. 100% flat pitch, idle, North;
2. Hover, North;
3. 100% flat pitch, idle, East;
4. Hover, East;
5. 100% flat pitch, idle, South;
6. Hover, South;
7. 100% flat pitch, idle, West;
8. Hover, West;
9. Takeoff, to West;
10. Approach, from East;

Table 7.1 shows the noise levels recorded from the test maneuvers at the three measurement stations. The takeoff maneuver was executed parallel to the measurement array approximately 30 feet to the south, using a relatively shallow ascent angle. Because of high wind speeds during the test, the pilot was not able to approach from the west over the measurement array. Instead, the pilot circled and approached from the east. Because the takeoff and approach maneuvers were not executed over the noise measurement array, the data are not directly comparable to other takeoff and approach data. The graphic recorder charts of SPL measured at Stations 1, 2, and 3 during the tests are shown in Figures 7.4, 7.5 and 7.6, respectively.

Table 7.2 shows ambient noise data recorded at Station 3 for three one-hour sample periods. The first two sample periods, which include one sample period without the helicopter test maneuvers and one sample period with the helicopter test maneuvers, were on the day of the standardized test maneuvers.

TABLE 7.1 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT EXECUTIVE HELICOPTER, INC.

Location: Executive Helicopter, Inc.
Date: June 19, 1984
Time: 1:00 p.m.
Helicopter Model: Bell 206B

Temperature: 80 F
Relative Humidity: 50%
Wind Speed: 13 knots from West

Station	Dist. From Pad (ft.)	100% Idle Approach Time (sec.)	Leq	SEL	Lmax	Hover (North) Time (sec.)	Leq	SEL	Lmax	100% Idle (East) Time (sec.)	Leq	SEL	Lmax	Hover (East) Time (sec.)	Leq	SEL	Lmax	100% Idle (South) Time (sec.)	Leq	SEL	Lmax
1	145	26	87.6	96.7	84.2	23	89.3	102.9	92.5	31	84.6	99.4	87.8	29	85.3	99.9	87.2	32	82.4	97.4	84.8
2	285	36	66.7	84.4	72.0	23	76.3	89.9	78.8	32	71.2	86.2	75.8	30	74.6	89.2	78.3	31	66.4	81.3	68.3
3	445				65				70				71				70				65

Station	Dist. From Pad (ft.)	Hover (South) Time (sec.)	Leq	SEL	Lmax	100% Idle (West) Time (sec.)	Leq	SEL	Lmax	Hover (West) Time (sec.)	Leq	SEL	Lmax	Takeoff [1][+] Time (sec.)	Leq	SEL	Lmax	Approach (East)[+] Time (sec.)	Leq	SEL	Lmax
1	145	32	85.5	100.5	87.7	31	77.8	92.8	81.1	31	81.2	96.1	85.5	13	88.2	99.3	94.7	15	78.1	90.8	83.2
2	285	31	74.5	88.3	78.1	31	63.7	78.6	66.1	31	68.5	83.4	70.8	15	85.4	97.1	92.5	-	-	-	-
3	445				71				63				66				89				71

All noise data recorded with A-frequency weighting and slow response time averaging.
- = No data obtained due to equipment malfunction.
[1] = Helicopter estimated at 80 feet altitude as it passed south of Station 3;
75 feet altitude as it passed south of Station 2 (photo scaling).
[+] = Noise data not directly comparable with corresponding data in other tests. See text.

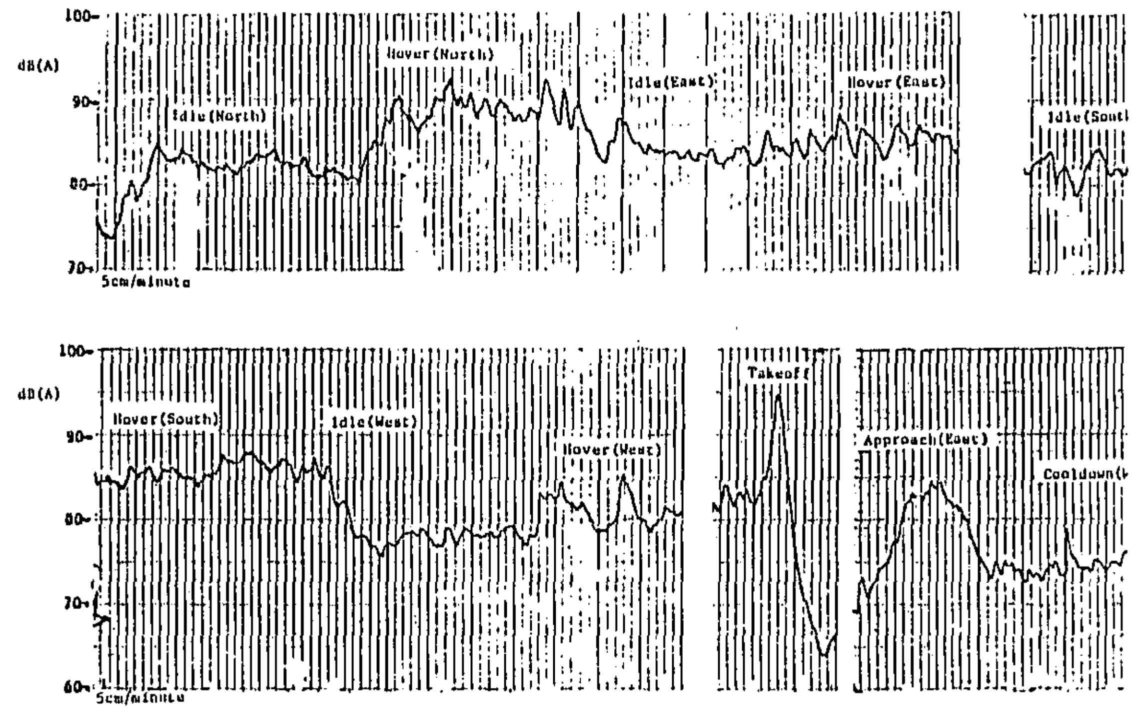


Figure 7.4 Sound Pressure Levels for Executive Helicopter, Inc. - Station 1

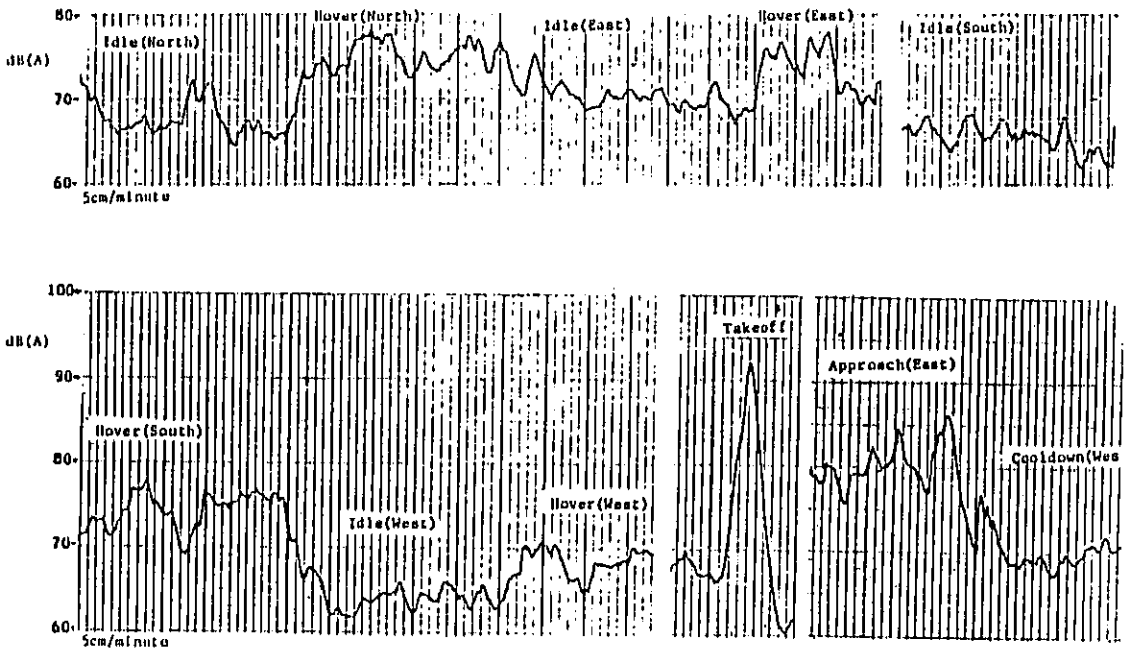


Figure 7.5 Sound Pressure Levels for Executive Helicopter, Inc. - Station 2

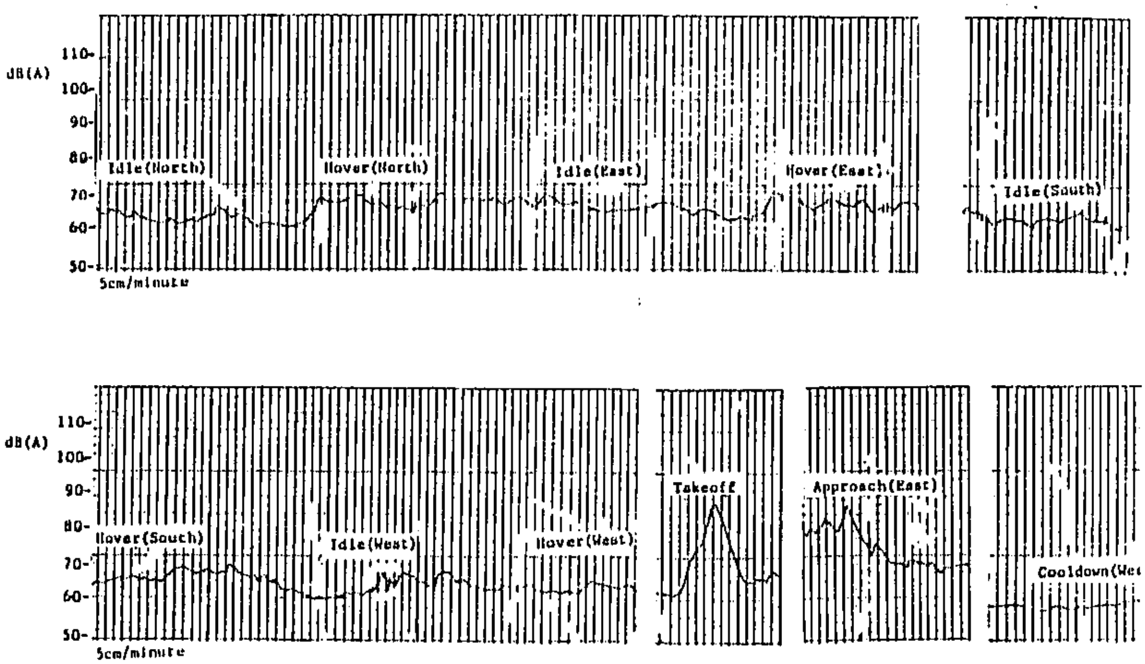


Figure 7.6 Sound Pressure Levels for Executive Helicopter, Inc. - Station 3

TABLE 7.2 AMBIENT NOISE LEVELS AT EXECUTIVE HELICOPTER, INC.

Location: Executive Helicopter, Inc.
Date: June 18, June 21, 1984
Time: 12:05 p.m.-2:05 p.m.(June 18)
11:25 a.m.-12:25 p.m.(June 21)
Helicopter Model: Bell 206B

Temperature: 80 F
Relative Humidity: 56%
Wind Speed: 13 knots from West

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient without helicopter test manouvers.	12:05-1:05 (June 18)	1 Hour	82[1]	86	81	67	57	53	52	51	68	Includes Idle(North) from test helicopter, moderate GA and jet traffic, and in-service helicopter operations.
Ambient with helicopter test	1:05-2:05 (June 18)	1 Hour	105[2]	103	89	76	58	55	53	52	80	Includes moderate GA and jet traffic.
Ambient without helicopter test manouvers.	11:25-12:25 (June 21)	1 Hour	101[3]	89	82	77	66	61	59	57	78	Includes moderate GA and jet traffic, helicopter landing and t.o.

All data were recorded with A-frequency weighting and slow response time averaging.
[1] Lmax from Bell 206B helicopter t.o. 50 ft. overhead.
[2] Lmax from business jet taxiing 30 ft. away.
[3] Lmax from commercial jet takeoff.

The test maneuvers lasted for approximately 11 minutes. The third sample period, without the helicopter test maneuvers, was three days later, with Station 3 at the same location as in the other two sample periods. Station 3 was located within 800 feet of the end of the airport runway; consequently several jet aircraft operations passed near the station, accounting for the high Leq levels recorded, between 68 dB(A) and 80 dB(A). Since the helipad is located at an airport with numerous jet aircraft operations, one would not expect the helicopter test maneuvers to make a significant contribution to existing ambient noise levels. Due to the varying number of aircraft and in-service helicopter operations during each of the one-hour sample periods, it is not possible to draw any firm conclusions, from the data, on the exact contribution of the helicopter test maneuvers to the existing ambient noise levels.

Table 7.3 presents selected Lmax values recorded at Station 3 during the ambient noise sample periods for noise not attributable to the helicopter test maneuvers (primarily commercial passenger jet operations), and the Lmax values recorded during the helicopter test maneuvers. Lmax values measured during jet takeoffs ranged from 81 dB(A) to 101 dB(A). The highest Lmax value measured, 105 dB(A), was generated by a jet taxiing 30 feet away from the microphone. By comparison, Lmax values measured for the helicopter test maneuvers ranged from 63 dB(A) for a helicopter at idle to 89 dB(A) for a helicopter takeoff.

7.2.2 WGN Television

WGN Television operates a private street level helipad at its studios in north Chicago (location 2 in Figure 7.1). Land use in the vicinity of the helipad is shown in Figure 7.7. The asphalt helipad is situated at the west end of the television

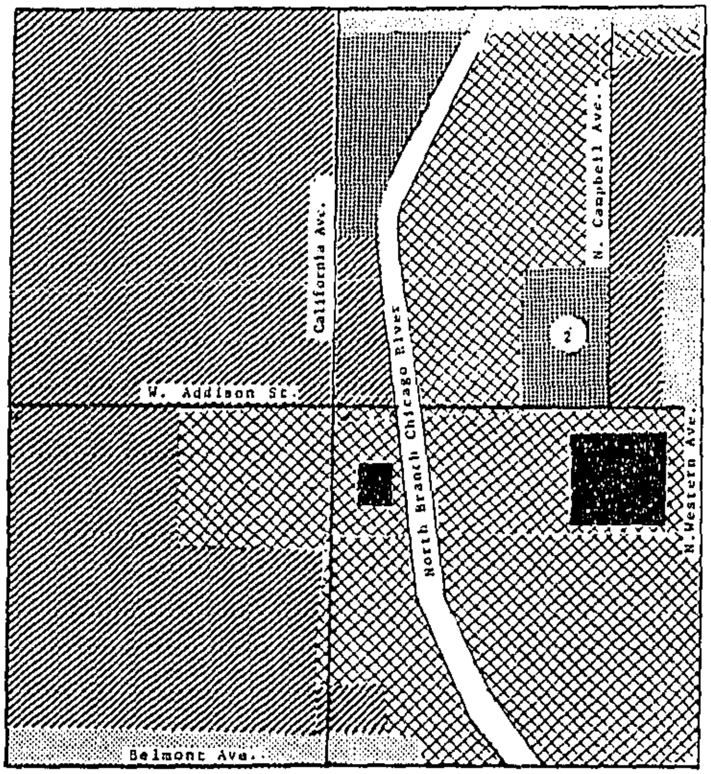
TABLE 7.3 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT EXECUTIVE HELICOPTER, INC.

Location: Executive Helicopter, Inc.
Date: June 18, June 21, 1984
Time: 12:05 p.m.-2:05 p.m. (June 18)
11:25 a.m.-12:25 p.m. (June 21)

Temperature: 80 F
Relative Humidity: 56%
Wind Speed: 13 knots from West

Event	Lmax	Event	Lmax
Traffic:		Takeoff 1000' away	83
		Takeoff 800' away	81
Oil truck 500' away	65	Takeoff 600' away	83
Oil truck 150' away	60	Takeoff 800' away	84
Oil truck 50' away	78	Takeoff 200' away	92
Van 50' away	50	Takeoff 800' away	83
Truck 800' away	67	Takeoff 600' away	101
Truck 100' away	61	Landing 800' away	70
Ambulance with siren		Landing 800' away	81
2000' away	56	Landing 800' away	86
		Landing 800' away	92
GA Aircraft Operations:		Landing 800' away	87
		Takeoff 200' away	101
Taxi 600' away	68	Landing 800' away	70
Taxi 100' away	60	Landing 800' away	81
Taxi 900' away	68	Landing 800' away	83
Taxi 50' away	77	Taxi 30' away	105
Taxi 10' away	74		
Taxi 30' away	75	In-Service Helicopter Operations:	
Taxi 150' away	71		
Taxi 50' away	72	Bell 206 approach 800' altitude	67
Takeoff 100' away	66	Bell 206 approach 800' altitude	70
Takeoff 1000' away	78	Bell takeoff 50' altitude	92
Takeoff 2000' away	68	Bell 206 idling 500' away	60
Takeoff 1000' away	84	Bell 206 hovering 500' away	72
Takeoff 1500' away	81	Bell 206 hovering 500' away	60
Takeoff 1500' away	86	Bell 206 idling 500' away	65
Takeoff 1500' away	80		
Landing 1000' away	68	Helicopter Test Maneuvers:	
Landing 1500' away	63		
Landing 2000' away	50	100% Idle(North)	65
Landing 30' away	98	Hover(North)	70
Warmup 300' away	78	100% Idle(East)	71
		Hover(East)	70
Jet Aircraft Operations:		100% Idle(South)	65
		Hover(South)	71
Warmup 500' away	92	100% Idle(West)	63
Warmup 800' away	68	Hover(West)	68
Warmup 500' away	60	Takeoff(overhead)	80
Takeoff 1000' away	93	Landing(East)	71

All noise data were recorded with A-frequency weighting and slow response time averaging.



Helipad Location:
2. WGN-Television

Legend:

Single Family Residential

Open Space/Parks

Commercial/Retail

Manufacturing/Light Industry

Airports and Waterways

Institutional/Schools

N

Source:
Land Use Map, Executive Helicopters,
June 17, 1984

Figure 7.7 Land Use in the Vicinity of WGN Television Helipad studio parking lot with a small vacant field immediately to the south. A five to six block area to the north, west, and south of the helipad is primarily composed of light manufacturing businesses. To the east of the helipad land use is primarily single-family residential housing. A large technical school is located two blocks to the south of the helipad.

Three noise monitoring stations were set up in a straight line 150 feet, 300 feet, and 450 feet south from the helipad, respectively. Figure 7.8 shows a site schematic of the noise monitoring locations and surrounding area as well as the flight paths used for the takeoff and approach maneuvers. The three noise monitoring stations were located on a grass surface in the vacant field south of the helipad. The television studio parking lot was situated approximately 50 feet to the east of Station 1. Addison Street ran east to west approximately 150 feet south of Station 3. Background Leq noise levels were in the range of 57dB(A) to 63 dB(A), mainly due to traffic on Addison Street.

Using an Enstrom F28 helicopter, the pilot at the WGN Television helipad performed 13 separate maneuvers, listed below in the order in which they occurred:

1. Approach, from South;
2. 100% flat pitch, idle, North;
3. Hover, North;
4. Hover, West;
5. 100% flat pitch, idle, West;
6. Hover, South;
7. 100% flat pitch, idle, South;
8. Hover, East;
9. 100% flat pitch, idle, East;
10. Takeoff, to North;

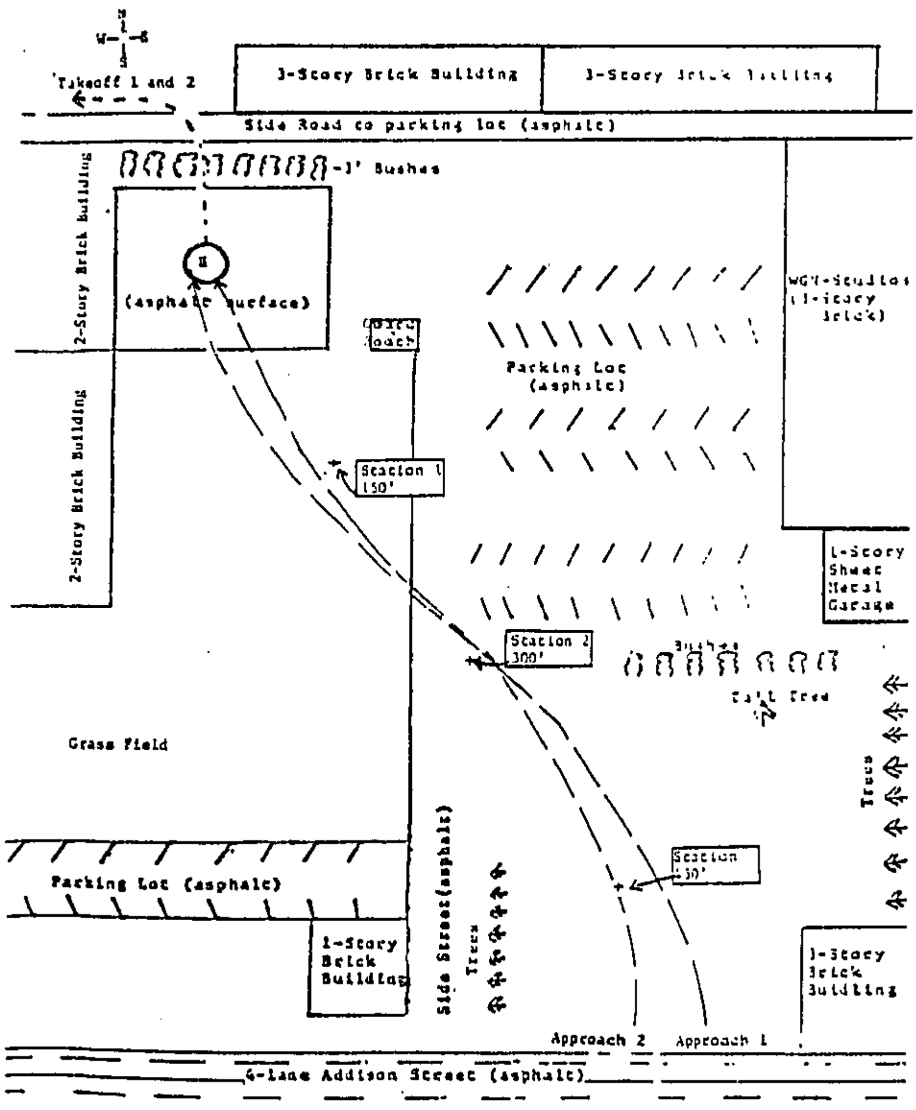


Figure 7.8 Site Schematic for WGN Television Test Site

11. Approach, from South;
12. Engine cooldown, North;
13. Takeoff, to North.

Table 7.4 shows the noise levels recorded from the test maneuvers at the three measurement stations. To avoid trees in the area, both approach maneuvers were executed using an "S-shaped" flight path into the helipad. The helicopter maintained the same altitude as it passed over stations 1 and 3. On the second approach, this "S-shaped" approach path resulted directly over Station 3, approximately 40 feet to the east of Station 2 and directly over Station 1. This may explain why Station 3 measured Lmax values within 1 dB(A) of Station 1 and an Lmax value 5.3 dB(A) higher than Station 2. Due to wind conditions in the area, the pilot was not able to perform takeoffs directly over the measurement array. On the second takeoff the helicopter hovered for approximately 10 seconds before ascending. The SPL graphic charts of the test maneuvers recorded at Stations 1, 2 and 3 are shown in Figures 7.9, 7.10 and 7.11, respectively.

Table 7.5 shows ambient noise data obtained at Station 3 during three consecutive one-hour sample periods. The first sample period includes the helicopter test maneuvers which lasted for approximately 17 minutes, the other two do not. Ambient Leq noise levels obtained in the absence of the helicopter test maneuvers were 57 dB(A) and 63 dB(A), and 64 dB(A) during the helicopter test maneuvers. However, the sample with a Leq of 63 dB(A) included several unscheduled operations by the test helicopter including a flyover at 500 feet altitude, an approach approximately 50 feet overhead, and a takeoff from the helipad. These three unplanned helicopter maneuvers contributed to an Leq level 6dB(A) higher than the ambient noise sample with no helicopter maneuvers present. The ambient noise sample that

TABLE 7.4 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT WGN TELEVISION

Location: WGN Television
Date: June 18, 1984
Time: 3:40 p.m.
Helicopter Model: Enstrom F28

Temperature: 84 F
Relative Humidity: 56%
Wind Speed: 3 - 8 knots from N

Sta-tion	Dist. From Pad (ft.)	Approach 1 [1]				100% Idle (North)				Hover (North)				Hover (West)				100% Idle (West)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	150	33	82.0	97.2	89.1	32	76.2	91.2	78.7	34	80.3	95.6	84.7	34	75.8	91.1	78.2	32	72.8	87.8	75.0
2	300	31	78.2	93.0	86.3	30	68.0	86.2	72.0	34	73.9	89.1	77.6	34	69.9	85.2	73.2	31	65.8	80.7	67.8
3	450				83				67				73				72				68

Sta-tion	Dist. From Pad (ft.)	Hover (South)				100% Idle (South)				Hover (East)				100% Idle (East)				Takeoff 1 (North)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	150	35	74.0	89.4	76.5	32	69.8	84.8	72.6	33	78.2	93.4	81.3	33	74.5	89.6	77.4	15	77.2	89.0	83.4
2	300	36	66.9	82.4	69.5	32	63.0	78.0	66.1	33	71.4	86.5	75.1	32	67.1	82.1	69.7	16	72.6	84.6	79.6
3	450				68				63				70				67				75

All noise data recorded with A-frequency weighting and slow response time averaging.
[1]=Helicopter estimated at 180' altitude directly over Station 3; 80' altitude directly over Station 2 (photo scaling).
[2]=Helicopter estimated at 120' altitude directly over Station 3; 80' altitude as it passed west of Station 3 (photo scaling).

(Table continued on next page)

TABLE 7.4 (continued)

Sta-tion	Dist. From Pad (ft.)	Approach 2 [2]				Cooldown (North)				Takeoff 2 (North)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	LEQ	SEL	Lmax
1	150	41	81.7	97.0	88.0	31	68.0	83.8	74.2	24	78.2	92.0	82.7
2	300	41	77.2	93.2	82.7	28	61.6	76.2	65.8	25	73.2	87.1	78.7
3	450				88				60				75

All noise data recorded with A-frequency weighting
and slow response time averaging.
[1]=Helicopter estimated at 100' altitude directly over Station 3;
80' altitude as it passed west of Station 2 (photo scaling).
[2]=Helicopter estimated at 120' altitude directly over Station 3;
80' altitude as it passed west of Station 2 (photo scaling).

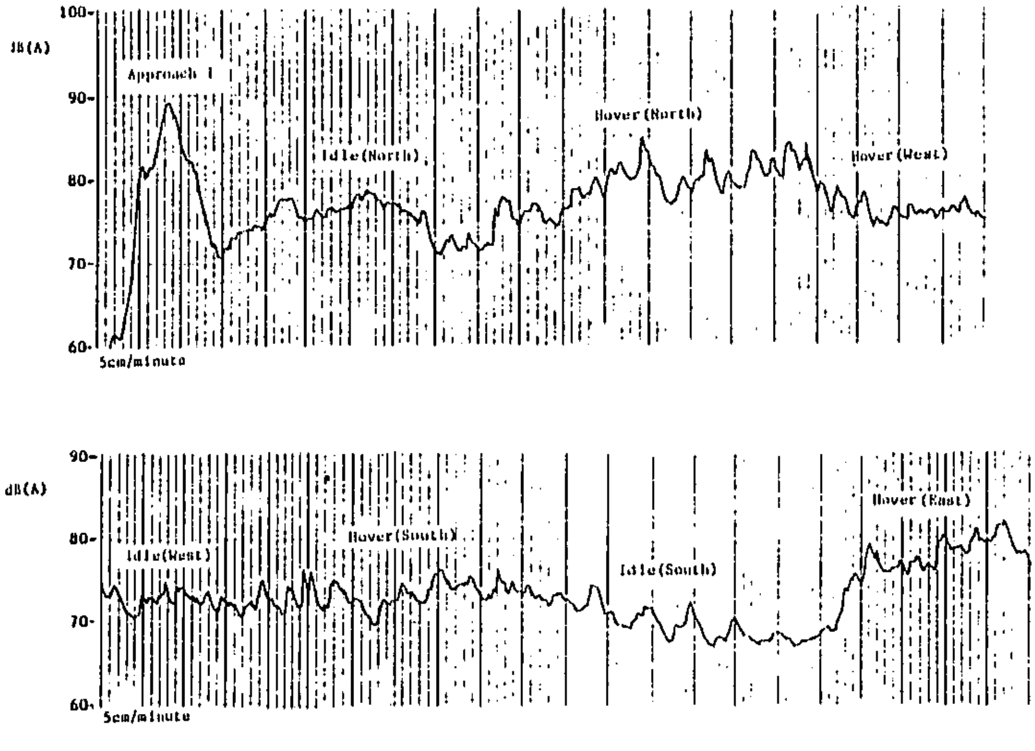


Figure 7.9 Sound Pressure Levels for WGN Television Test - Station 1

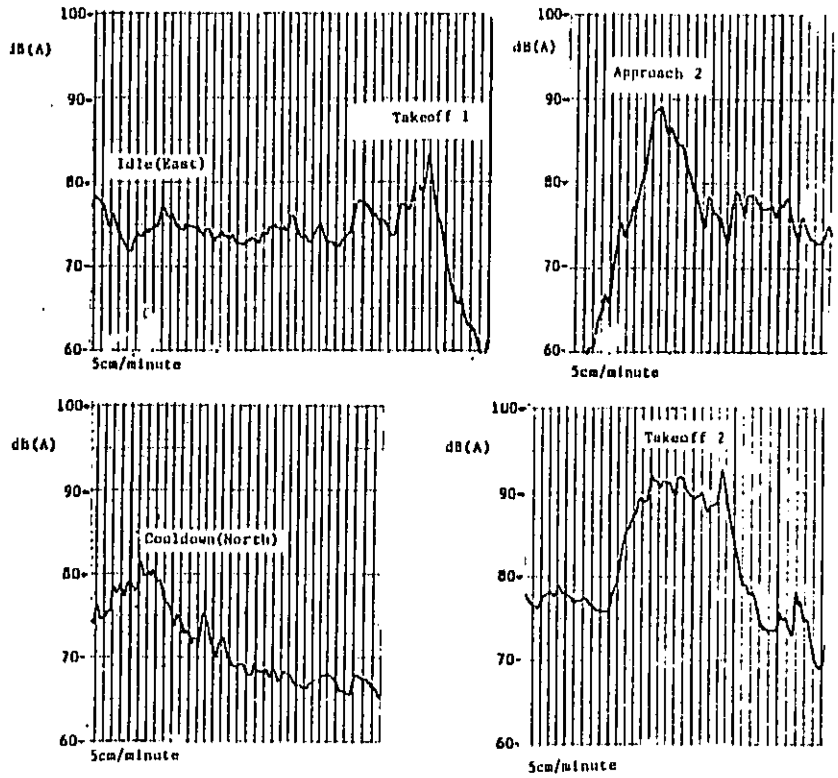
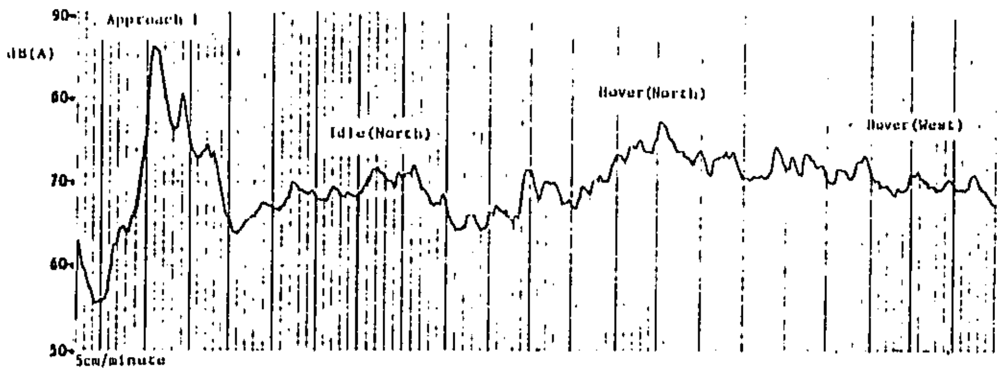


Figure 7.9 (continued)



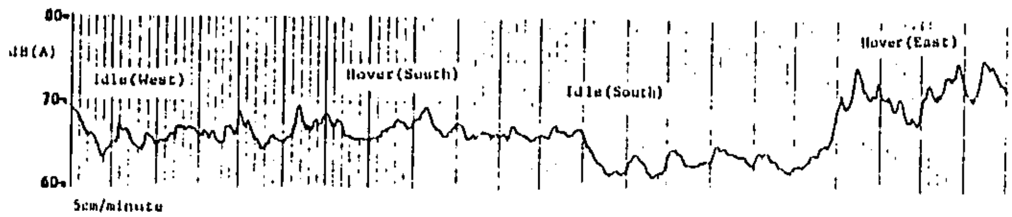


Figure 7.10 Sound Pressure Levels for WGN Television Test - Station 2

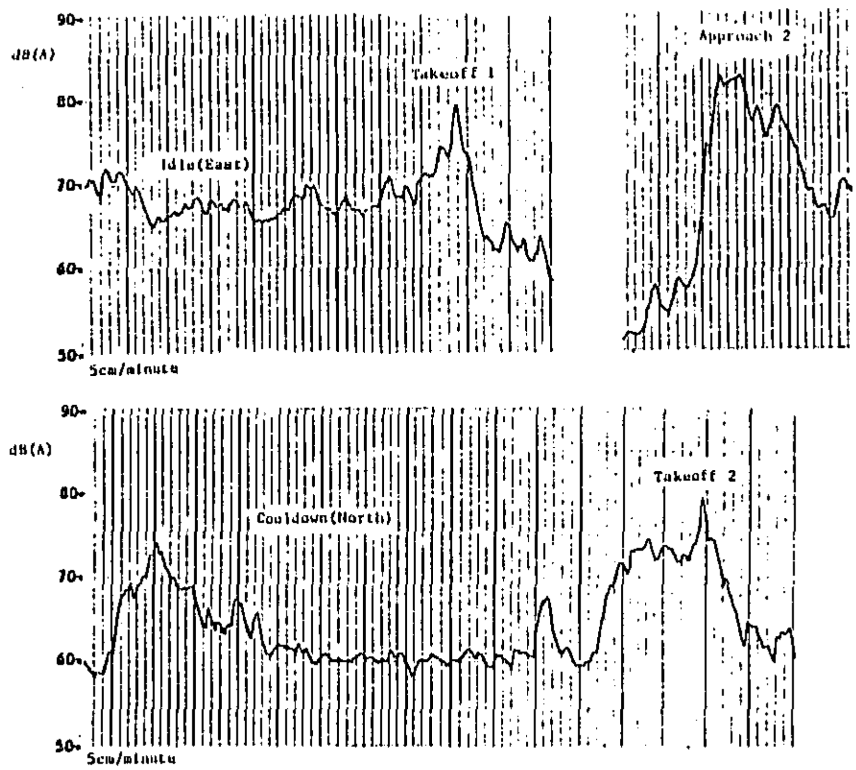


Figure 7.10 (continued)

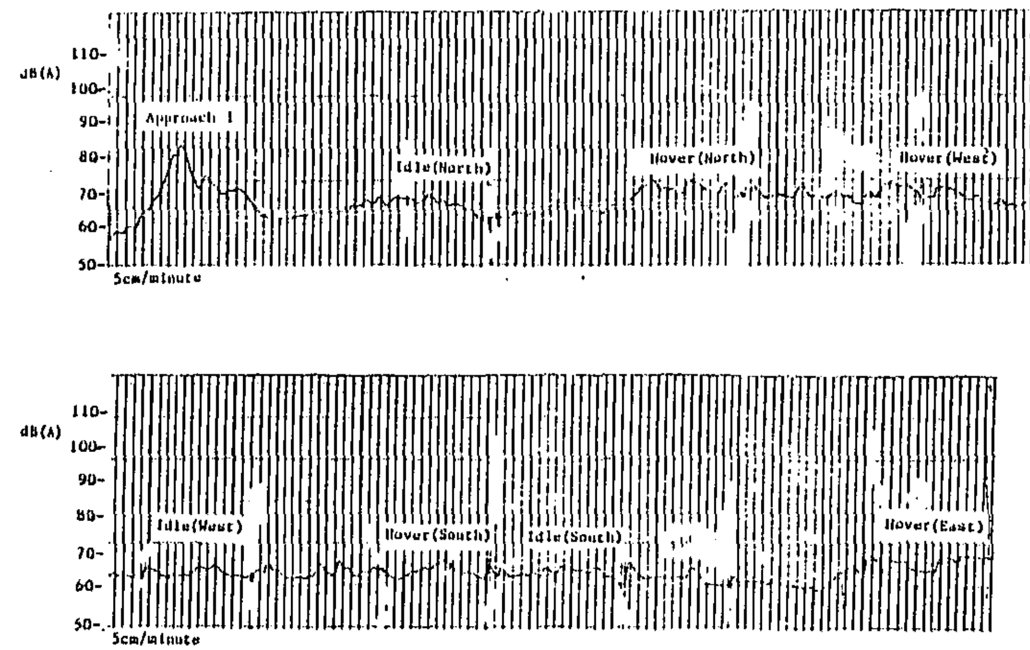


Figure 7.11 Sound Pressure Levels for WGN Television Test - Station 3

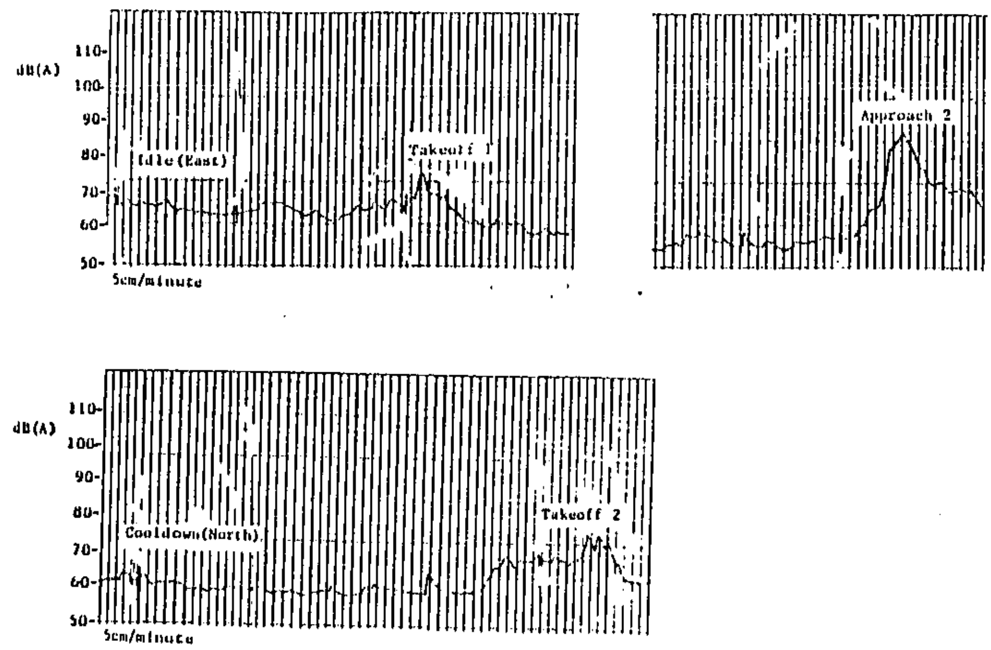


Figure 7.11 (continued)

TABLE 7.5 AMBIENT NOISE LEVELS AT WGN TELEVISION

Location: WGN Television
Date: June 18, 1984
Time: 3:15 p.m.-6:15 p.m.
Helicopter Model: Enstrom F28

Temperature: 84 F
Relative Humidity: 56%
Wind Speed: 3 - 6 knots from N

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient with helicopter test maneuvers.	3:15-4:15	1 Hour	88[1]	85	73	60	57	55	53	52	64	Includes moderate street traffic 200-300 feet away, loud shout 200 feet away, and 2 car horns 200' away.
Ambient without helicopter test maneuvers.	4:15-5:15	1 Hour	72[2]	70	64	59	55	54	52	52	57	Includes moderate street traffic 200-300 feet away, 2 jet flyovers, 2 screams, car horn, fire truck alarm, and electric fan 200' away.
Ambient without helicopter test maneuvers.	5:15-6:15	1 Hour	89[3]	87	72	59	55	53	52	52	63	Includes moderate street traffic 200-300 feet away, helo flyby 500' altitude and west of station, helo approach directly over station at 50' altitude, helo takeoff from WGN-TV, 2 jet flybys.

All noise data were recorded with A-frequency weighting and slow response time averaging.
[1] = Lmax recorded from test helicopter approach.
[2] = Lmax recorded from jet flyover at 5000' altitude.
[3] = Lmax recorded from helicopter approach directly over station at 50' altitude.

included all of the helicopter test maneuvers present resulted in an Leq level 7dB(A) higher than the ambient noise sample with no helicopter maneuvers present.

The exceedance level data indicates that the sound level was above 66 dB(A) 10 percent of the time (L10) in the sample obtained during the helicopter test maneuvers compared to 59 dB(A) in the sample with the three unplanned helicopter maneuvers and 58 dB(A) in the sample without any helicopter maneuvers.

Table 7.6 presents selected Lmax values recorded at Station 3 from non-helicopter noise events and from the helicopter test maneuvers performed during the ambient noise sample periods. The loudest non-helicopter related noise event was generated by a bus, approximately 200 feet away on Addison Street, registering a Lmax of 80dB(A). Street traffic on Addison Street (excluding the bus) registered Lmax values between 57dB(A) (another bus) and 68dB(A) (a motorcycle at 200 feet). For comparison, the helicopter test maneuvers generated Lmax values from 63 dB(A) for an idle facing south to 88 dB(A) for an approach.

7.2.3 Meigs Field Airport

Meigs Field airport (location 3 in figure 7.1) has four public use helipads located on the taxiway at the west end of the airport. Land use in the vicinity of Meigs Field is shown in Figure 7.12 The airport is situated on a small peninsula on Lake Michigan surrounded by water to the east, south, and west. A small park is located at the northern end of the runway and a yacht club with several boats in dock is located to the west, between the airport and the Lake Michigan coast line. A 2-block wide strip of beaches and parkland extends north and south along the mainland coastline. A major railroad line and the downtown CBD are located to the west, beyond the beaches and parkland.

TABLE 7.8 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3 WGN TELEVISION

Location: Chevron Oil, Inc.
Date: Aug. 6, 1984; Aug. 8, 1984
Time: 3:15 p.m-6:15 p.m.

Temperature: 84 F
Relative Humidity: 56%
Wind Speed: 3 - 6 knots from N

Event

Traffic:	Lmax	Aircraft Activity:	Lmax
Car accelerating 300' away.	65	Commercial jet overhead at 6000' altitude.	72
Car accelerating 200' away.	59	Distant commercial jet flyover.	59
Car 200' away.	65	Commerical jet 1200' overhead.	69
Same as above.	61	Helicopter approach directly over station at 50' altitude.	89
Same as above.	64	Helicopter takeoff from WGN to North.	78
Same as above.	60	Helicopter flyby at 500' altitude and 500' west of station.	70
Car 400' away.	58		
Same as above.	62	**Miscellaneous:**	
Metrobus 200' away.	62	Scream 200' away.	63
Same as above.	60	Same as above.	58
Same as above.	60	Electric fan at warehouse 400' away.	58
Same as above.	60	Banging sound 600' away.	62
Same as above.	62	Same as above.	61
Same as above.	61	Same as above.	62
Same as above.	62	Trash can lid slam.	60
Same as above.	57		
Same as above.	60	**Helicopter test maneuvers:**	
Metrobus 400' away.	61	Approach 1 (from South)	63
Same as above.	61	Idle(North)	67
Truck passing 200' away.	59	Hover(North)	73
Same as above.	61	Hover(West)	72
Same as above.	67	Idle(West)	66
Same as above.	60	Hover(South)	66
Heavy truck 200' away.	60	Idle(South)	63
Same as above.	59	Hover(East)	70
Same as above.	63	Idle(East)	67
Dump truck 200' away.	62	Takeoff 1 (to North)	75
Truck accelerating 200' away.	62	Approach 2 (from South)	88
Car horn 200' away.	58	Cooldown (North)	60
Same as above.	60	Takeoff 2 (to North)	75
Motorcycle 250' away.	70		
Motorcycle 200' away.	61		
Same as above.	68		
Fire truck alarm 1000' away.	65		

All noise data were recorded with A-frequency weighting and slow response time averaging.

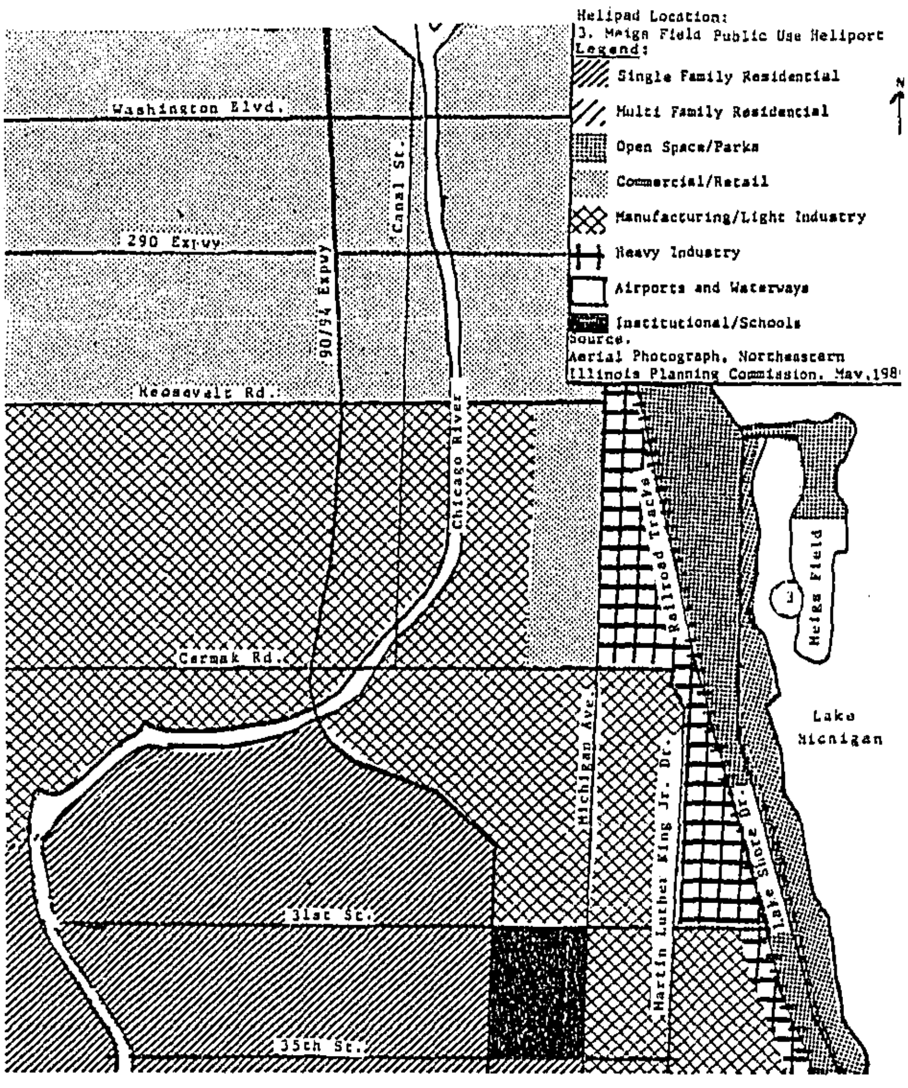


Figure 7.12 Land Use in the Vicinity of Meigs Field Airport Helipads

The tests were conducted at Helipad No. 2. Three noise monitoring stations were set up in a straight line at distances 155 feet, 305 feet and 455 feet, respectively, south from Helipad #2. Figure 7.13 shows a site schematic of the noise

monitoring station locations and surrounding areas, as well as the flight paths used on the takeoff maneuvers. The three noise monitoring stations were located on the asphalt general aviation parking area just west of the airport taxiway. The stations were situated between two rows of parked general aviation aircraft. Several general aviation takeoff and landing operations were primary sources of intrusive noise during the ambient noise measurement periods: ambient noise Leq measurements were in the mid 70 dB(A) range.

The test helicopter was a Hughes 500 D supplied by Crescent Helicopter, Inc. The pilot performed 10 separate maneuvers, listed below in the order in which they occurred:

1. Approach, from south;
2. 100% flat pitch, idle, north;
3. Hover, north;
4. Hover, east;
5. 100% flat pitch, idle, east;
6. Hover, south;
7. 100% flat pitch, idle, south;
8. Hover, west;
9. 100% flat pitch, idle, west;
10. Takeoff, to north.

Table 7.7 shows the noise levels recorded during the test maneuvers at the three measurement stations. The approach maneuver was executed parallel to and approximately 30 feet east of the measurement array. The helicopter approached at a very

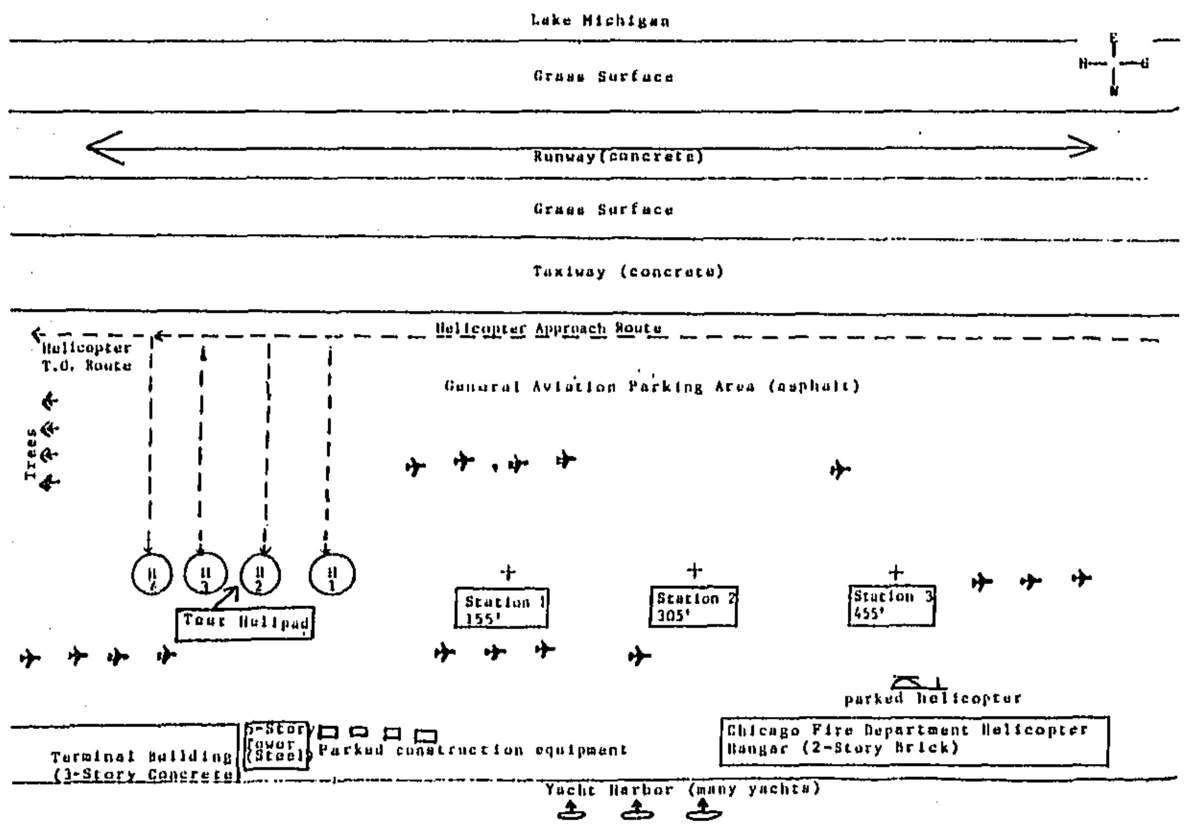


Figure 7.13 Site Schematic for Meigs Field Test Site

TABLE 7.7 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT MEIGS FIELD AIRPORT

Location: Meigs Field Airport
Date: June 20, 1984
Time: 10:00 a.m.
Helicopter Model: Hughes 500D

Temperature: 63 F
Dew Point: 60
Wind Speed: 13 knots from North

Station	Dist. From Pad (ft.)	Approach (1)				100% Idle (North)				Hover (North)				Hover (East)				100% (Idle)(East)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	155	-	-	-	-	29	83.8	98.2	84.8	30	86.4	101.2	88.5	34	92.1	107.4	93.4	41	87.2	103.3	87.8
2	305	48	83.8	101.1	88.6	28	75.7	90.1	77.1	31	79.8	84.7	82.1	38	86.4	101.9	88.0	41	81.0	97.1	82.8
3	455				88				73				77				84				80

Station	Dist. From Pad (ft.)	Hover (South)				100% Idle (South)				Hover (West)				100% Idle (West)				Takeoff (North)[+]			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	155	31	84.2	99.1	86.8	31	82.2	97.1	84.8	31	89.5	104.3	91.3	32	83.7	98.7	85.0	12	84.4	95.2	91.2
2	305	31	78.6	93.4	80.6	30	76.2	90.8	78.4	31	82.7	97.5	85.1	31	75.7	90.6	78.1	13	77.3	89.1	84.2
3	455				75				74				80				72				78

All noise data recorded with A-frequency weighting and slow response time averaging.
- = no data obtained due to equipment malfunction.
* Background noise too high to detect maneuver.
(1)=Helicopter estimated at 175' altitude directly over Station 3; 150' altitude directly over Station 2 (visual judgement).
(+)=Noise data not directly comparable with corresponding data in other tests. See text.

shallow descent angle, accounting for the similar Lmax values recorded at Stations 2 and 3. Wind conditions at the airport caused the helicopter to take off to the north, into the wind, and away from the measurement array. (For this reason, the take-off data in this series of tests are not directly comparable to other takeoff data.) The SPL charts of the test maneuvers recorded at Stations 1, 2 and 3, are shown in Figures 7.14, 7.15 and 7.16, respectively.

Table 7.8 presents ambient noise level data obtained at Station 3 for three consecutive one-hour sample periods. The first two sample periods do not include the helicopter test maneuvers, the third sample does. The second sample period also includes two in-service helicopter approaches. The Leq levels recorded for all three sample periods vary within a range of only 3 dB(A). The Leq level for the sample period with the helicopter test maneuvers which lasted for approximately 21 minutes was higher than the Leq observed in the two sample periods without helicopter tests by 2 dB(A) and 3 dB(A), respectively. However, the differing numbers of general aviation aircraft operations and in-service helicopter operations that occurred during the three sample periods make the exact contribution of the helicopter test maneuvers to the ambient noise level uncertain. Table 7.9 shows selected Lmax values recorded at Station 3 during the three ambient noise sample periods. The data include Lmax values from non-helicopter noise sources as well as for the helicopter tests. Most of the intrusive noise occurrences were general aviation operations at the airport that produced Lmax values ranging from 64 dB(A) for a business jet engine warm-up approximately 800 feet away to 102 dB(A) for a business jet takeoff approximately 500 feet away. The Lmax values for the helicopter test maneuvers ranged from 72 dB(A) for a idle facing facing west to 88 dB(A) for the approach. These levels are well within those resulting from general aviation aircraft operations at the airport.

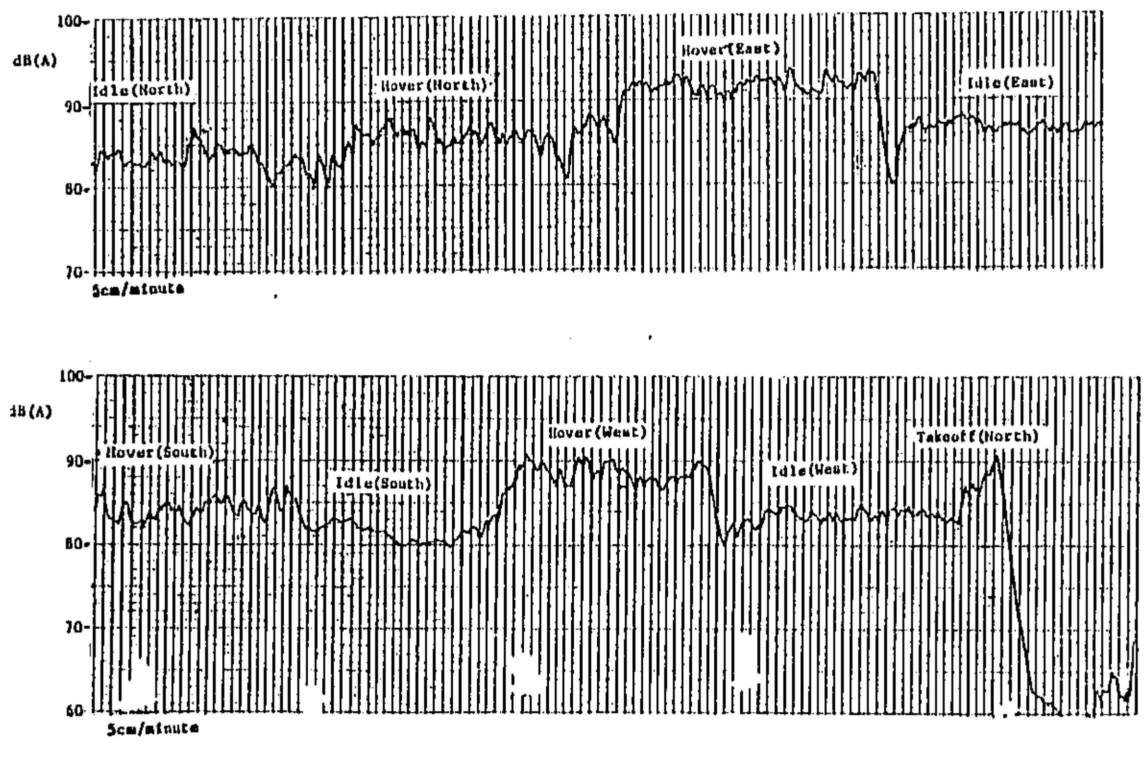


Figure 7.14 Sound Pressure Levels for Meigs Field Airport Test - Station 1

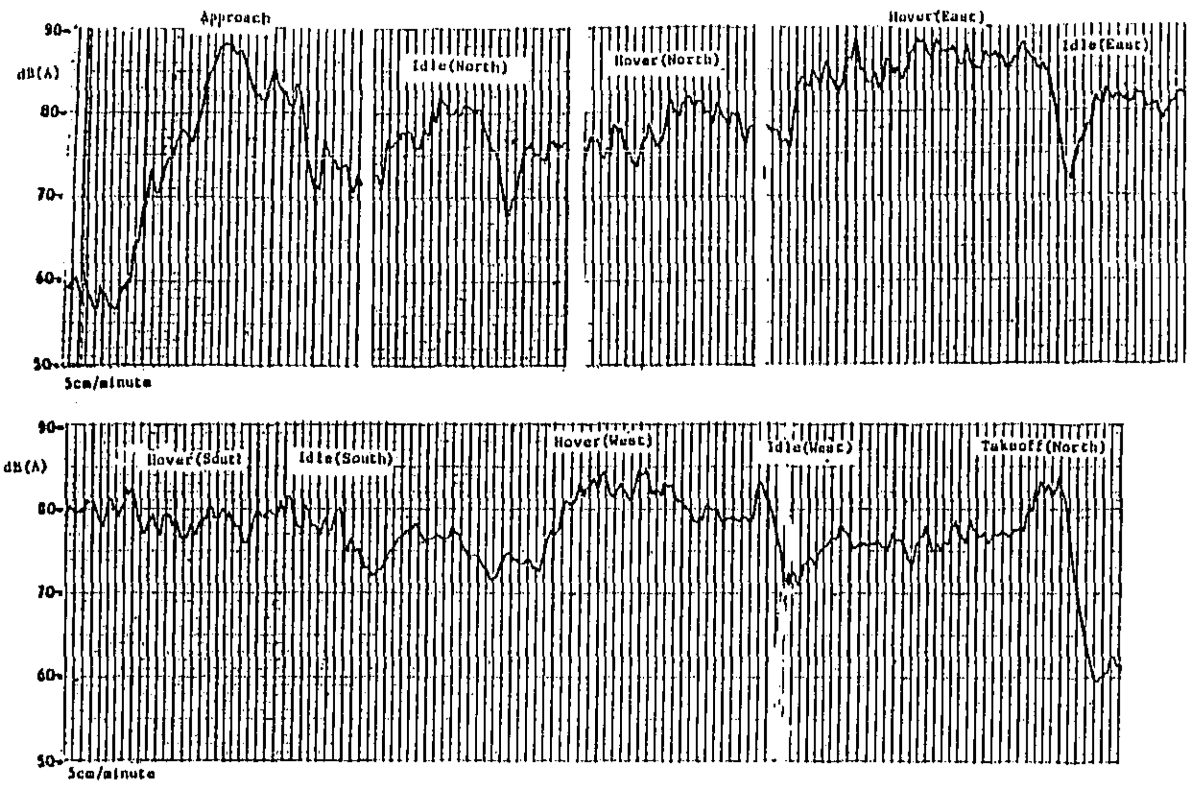


Figure 7.15 Sound Pressure Levels for Meigs Field Airport Test - Station 2

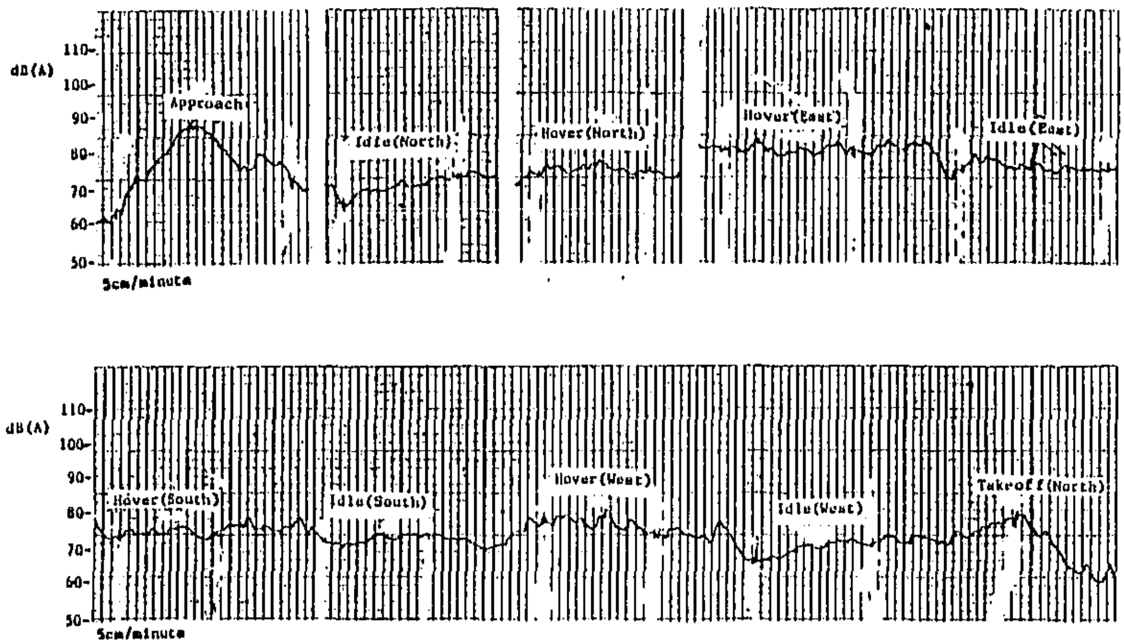


Figure 7.16 Sound Pressure Levels for Meigs Field Airport Test - Station 3

TABLE 7.8 AMBIENT NOISE LEVELS AT MEIGS FIELD AIRPORT

Location: Meigs Field Airport
Date: June 20, 1984
Time: 8:50 a.m. – 11:00 a.m.
Helicopter Model: Hughes 500D

Temperature: 63 F
Dew Point: 60
Wind Speed: 13 knots from North

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient without helicopter test maneuvers.	8:50-9:50	1 Hour	90[1]	87	82	68	60	56	54	54	73	Includes moderate GA activity.
Ambient without helicopter test maneuvers.	9:50-10:50	1 Hour	97[2]	96	86	72	61	57	55	53	74	Includes moderate GA activity, Bell 206B and Hughes 500D landing.
Ambient with helicopter test maneuvers.	10:50-11:50	1 Hour	102[3]	89	88	77	63	57	56	55	76	Includes moderate GA activity.

All data were recorded with A-frequency weighting and slow response time averaging.
[1] Lmax from GA plane taxiing 50' away.
[2] Lmax from GA plane taxiing 50' away.
[3] Lmax from business jet takeoff 500' away.

TABLE 7.9 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3 MEIGS FIELD AIRPORT

Location: Meigs Field Airport
Date: June 20, 1984
Time: 8:50 a.m. – 11:50 a.m.

Temperature: 83 F
Dew Point: 60
Wind Speed: 13 knots from North

Event	Lmax
Traffic:	
Oil truck 150' away	63
Oil truck 50' away	70
Van 60' away	62
Van 10' away	69
Van 10' away	66
Van 10' away	65
Van accelerating 300' away	83
Truck 50' away	73
Car 20' away	62
GA Aircraft Operations:	
Business jet taxi 50' away	98
Small single prop plane 50' away	89
Taxi 300' away	72
Taxi 50' away	73
Taxi 100' away	66
Taxi 100' away	72
Taxi 500' away	77
Takeoff 500' away	86
Takeoff 500' away	83
Takeoff 500' away	80
Takeoff 500' away	83
Takeoff 500' away	84
Takeoff 500' away	79
Takeoff 500' away	93
Takeoff 500' away	102
Takeoff 500' away	86
Landing 500' away	87
Business jet engine cooldown 1000' away	88
Business jet engine warmup 800' away	64

Event	Lmax
In-Service Helicopter Operations:	
Bell 206B approach overhead at 75' altitude.	88
Hughes 500D approach overhead at 75' altitude	88
Helicopter Test Maneuvers:	
Approach	89
Idle(North)	73
Hover(North)	77
Hover(East)	84
Idle(East)	80
Hover(South)	75
Idle(South)	74
Hover(West)	80
Idle(West)	72
Takeoff(North)	78

All noise data were recorded with A-frequency weighting and slow response time averaging.

7.2.4 University of Chicago Hospital

The helipad at the University of Chicago Hospital is located on the roof of the main building, approximately 90 feet above ground. (Location 4 in Figure 7.1). Land use in the vicinity of the helipad is shown in Figure 7.17. A large 10 square block park lies to the west of the helipad, and a large open grass esplanade runs east to west on the south edge of the hospital. Land use immediately to the north of the hospital is medium density multi-family housing. Land use further north and to the east of the hospital is primarily single-family residential.

Three noise monitoring stations were set up at distances of 108 feet, 433 feet and 588 feet from the helipad, along a line extending to the south. Figure 7.18 shows a site schematic of the noise monitoring locations and surrounding areas as well as the flight paths used for the takeoff and approach maneuvers. Station 1 was located on the gravel-covered roof next to the helipad. Parts of the hospital building rose 20 feet above the level of the helipad approximately 50 feet to the west and east. An airconditioning unit on the roof approximately 45 feet away from Station 1 was operating throughout the test maneuvers . Ambient noise measurement during several short periods before the tests began showed Leq levels of 65 dB(A) on the roof.

Station 2 was located at street level on a concrete sidewalk next to a courtyard of the hospital building. Several cars entering the courtyard parking lot contributed to high ambient noise levels around this station. Station 3 was located across the street from Station 2 on the grass esplanade. Background ambient noise levels around Station 3 were relatively low with Leq levels between 57 dB(A) and 61 dB(A), resulting mainly from light automobile traffic on a street 30 feet south of the station.

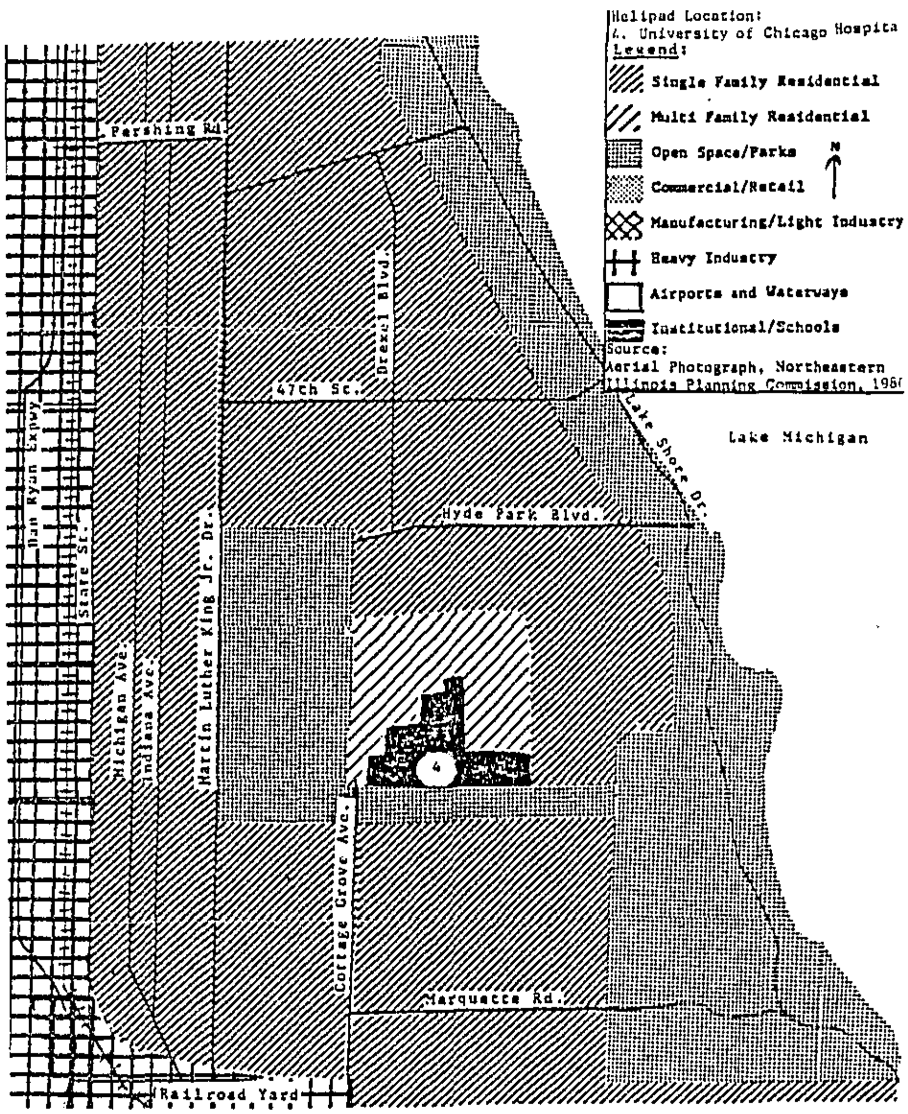


Figure 7.17 Land Use in the Vicinity of University of Chicago Hospital

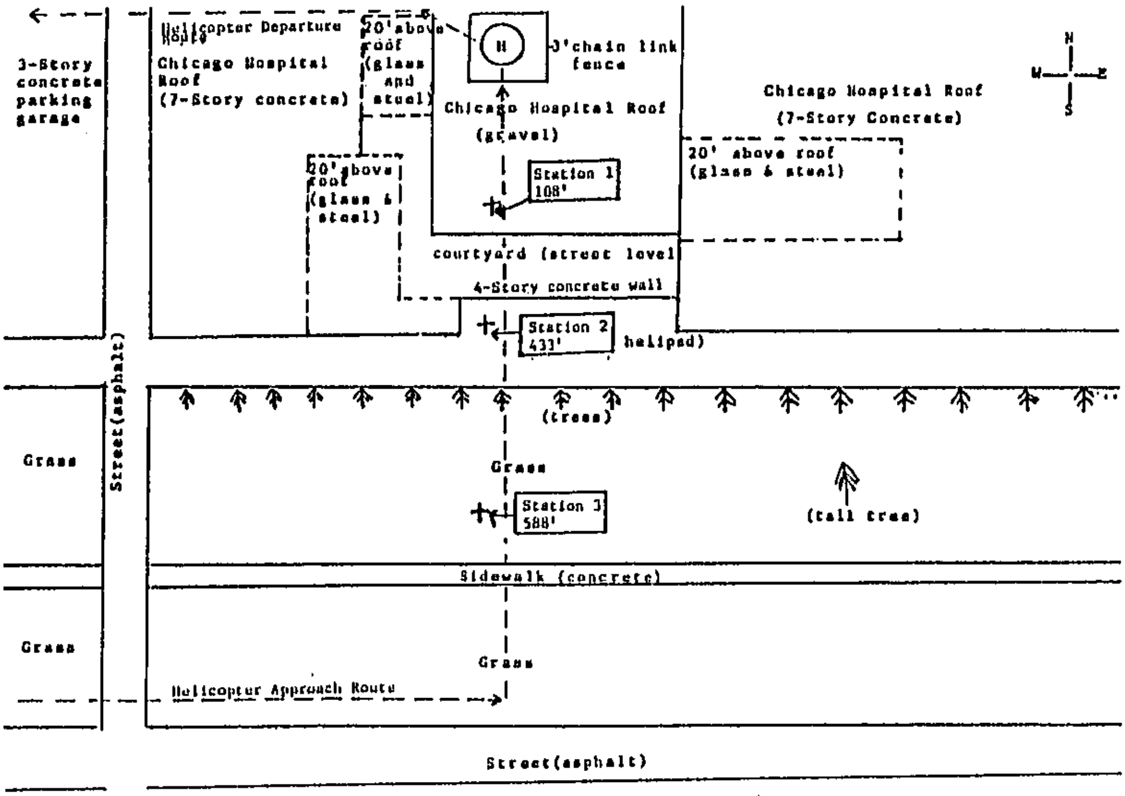


Figure 7.18 Site Schematic for University of Chicago Hospital Test Site

The helicopter pilot at the hospital helipad performed ten separate maneuvers with an Aerospatiale Twinstar helicopter. The following are the maneuvers in the order in which they occurred:

1. Approach, from south;
2. 62% flat pitch, idle, north;
3. 100% flat pitch, idle, north;
4. Hover, north;
5. Hover, east
6. 100% flat pitch, idle, north;
7. Hover, south;
8. Hover, north;
9. 62% flat pitch, idle, north;
10. Takeoff, to west.

Table 7.10 shows the noise levels of the tests as recorded at the three measurement stations. For safety reasons, idle maneuvers were not performed facing south and west and hover maneuvers were not performed facing south. Lmax values recorded at Station 2 during the test maneuvers were 16 dB(A) to 22 dB(A) lower than those recorded at Station 1. This large difference is a result of several factors: the unusual close proximity of Station 1 to the helipad (433 feet); the unusual distance of Station 2 from the helipad (433 ft.); and because Station 2 was below the level of the helipad with the four-story concrete wall of the building acting as a substantial barrier blocking the sound waves from the helipad to the station. Noise levels produced in some of the helicopter maneuvers could not be detected at Stations 2 or 3 because of other intrusive noise events that occurred in the vicinity of the stations during the maneuvers. For example, several cars entered the parking area next to Station 2 during the two round idle maneuvers facing north.

TABLE 7.10 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT UNIVERSITY OF CHICAGO HOSPITAL

Location: University of Chicago Hospital
Date: June 20, 1984
Time: 1:30 p.m.
Helicopter Model: Aerospatiale Twinstar

Temperature: 72 F
Dew Point: 35
Wind Speed: 10 knots from N

Station	Dist. From Pad (ft.)	Approach (1) Time (sec.)	Leq	SEL	Lmax	62% Idle (North) Time (sec.)	Leq	SEL	Lmax	100% Idle (North) Time (sec.)	Leq	SEL	Lmax	Hover (North) Time (sec.)	Leq	SEL	Lmax	Hover (West) Time (sec.)	Leq	SEL	Lmax
1	100	60	92.8	110.5	100.1	37	78.5	92.1	77.5	48	85.0	101.8	88.8	27	92.7	109.8	94.8	11	93.0	104.2	98.5
2	433	65	70.0	88.0	88.0	*	*	*	*	48	60.3	72.2	66.7	28	69.3	83.7	72.8	-	-	-	-
3	600				85				63				64				71				77

Station	Dist. From Pad (ft.)	Hover (East) Time (sec.)	Leq	SEL	Lmax	100% Idle (East) Time (sec.)	Leq	SEL	Lmax	Hover (South) Time (sec.)	Leq	SEL	Lmax	Hover (North) Time (sec.)	Leq	SEL	Lmax	62% Idle (North) Time (sec.)	Leq	SEL	Lmax
1	100	22	84.8	90.8	88.0	21	88.4	101.6	90.3	22	91.3	104.7	95.7	28	91.4	106.0	93.7	38	86.4	101.3	95.0
2	433	-	-	-	-	21	65.7	78.8	67.7	13	75.6	86.7	80.2	34	72.5	87.8	78.6		*	*	*
3	600				77				*				74				-				61

All noise data recorded with A-frequency weighting and slow response time averaging.
- = no data obtained due to equipment malfunction.
* Background noise too high to detect maneuver.
(1)=Helicopter estimated at 175' altitude directly over Station 3; 150' altitude directly over Station 2 (visual judgement).
(+)=Noise data not directly comparable with corresponding data in other tests. See text.

(Table continued on next page)

TABLE 7.10 (continued)

Station	Dist. From Pad (ft.)	Takeoff (West)(+)			
		Time (sec.)	Leq	SEL	Lmax
1	108	20	87.4	100.3	94.1
2	433	-	-	-	-
3	588				72

All noise data recorded with A-frequency weighting and slow response time averaging.
- = no data obtained due to equipment malfunction.
* Background noise too high to detect maneuver.
(1)=Helicopter estimated at 175' altitude directly over Station 3; 150' altitude directly over Station 2 (visual judgement).
(+)=Noise data not directly comparable with corresponding data in other tests. See text.

The approach maneuver was executed directly over the measurement array. Because of noise abatement rules governing use of the helipad, the helicopter had to depart to the west, perpendicular to the measurement array, rather than directly over it. (For this reason, the takeoff data in this series of tests are not directly comparable to other takeoff data.) Charts of SPL for the test maneuvers recorded at Stations 1, 2 and 3 are shown in figures 7.19, 7.20 and 7.21 respectively.

Table 7.11 presents ambient noise level data measured in four one-hour sample periods at Station 3. The first three periods were on the day preceding the helicopter test and do not include any helicopter noise. The fourth period, measured the following day at the same location as the first three periods, included all the helicopter test maneuvers which lasted for approximately 32 minutes. The data show the Leq level during the helicopter tests to be from 6 dB(A) to 10 dB(A) above the Leq levels of the three non-helicopter ambient noise sample periods. All of the ambient noise sample periods included light automobile activity, and some occasional aircraft overflights.

Table 7.12 shows Lmax values recorded at Station 3 during the four ambient noise sample periods for various non-helicopter intrusive noise events and for the helicopter tests. The source of most of the intrusive noise events was street traffic on a street 30 feet south of Station 3. Lmax values of the street traffic ranged from 57 dB(A) for a car, to 87 dB(A) for an ambulance with a siren 20 feet away. Lmax values from aircraft and in-service helicopter traffic ranged from 58 dB(A) from a GA overflight to 88 dB(A) for an unscheduled in-service approach by the test helicopter. By comparison, the helicopter test maneuvers produced Lmax values that ranged from 61 dB(A) for the

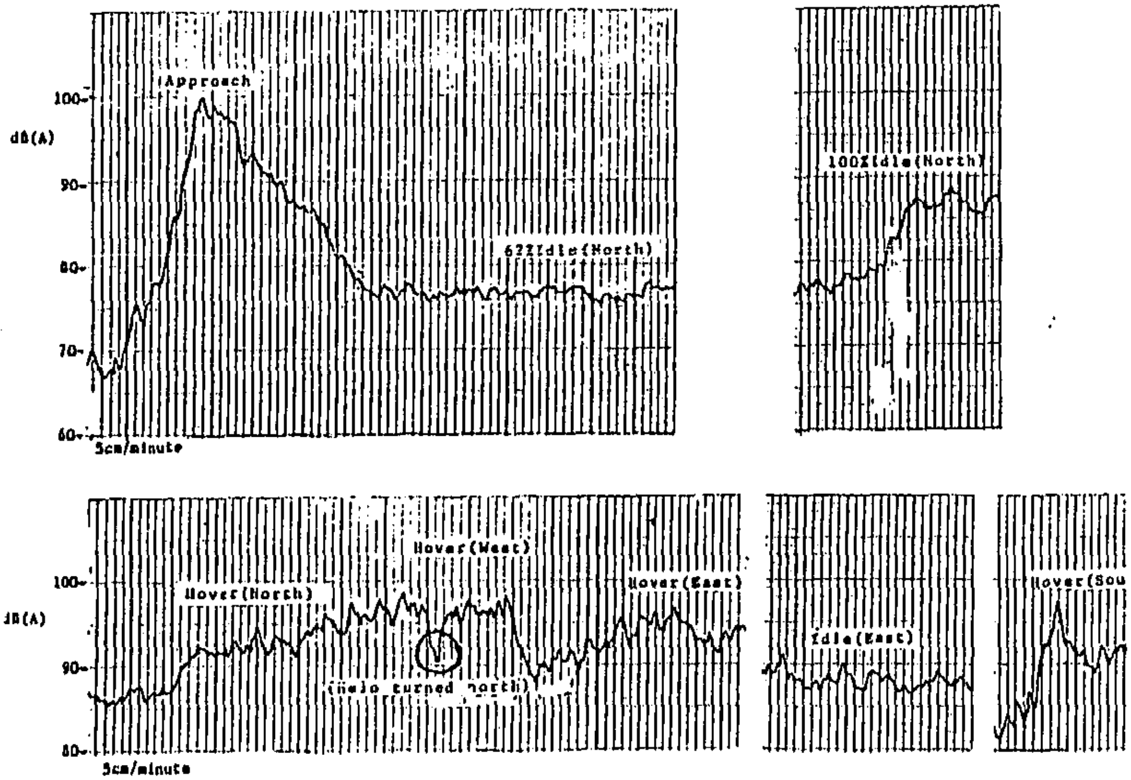


Figure 7.19 Sound Pressure Levels for University of Chicago Hospital Test Station 1

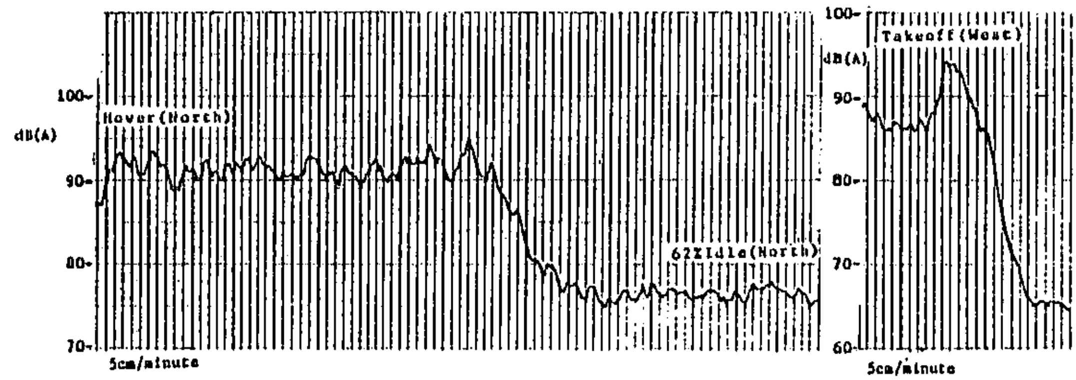


Figure 7.19 (continued)

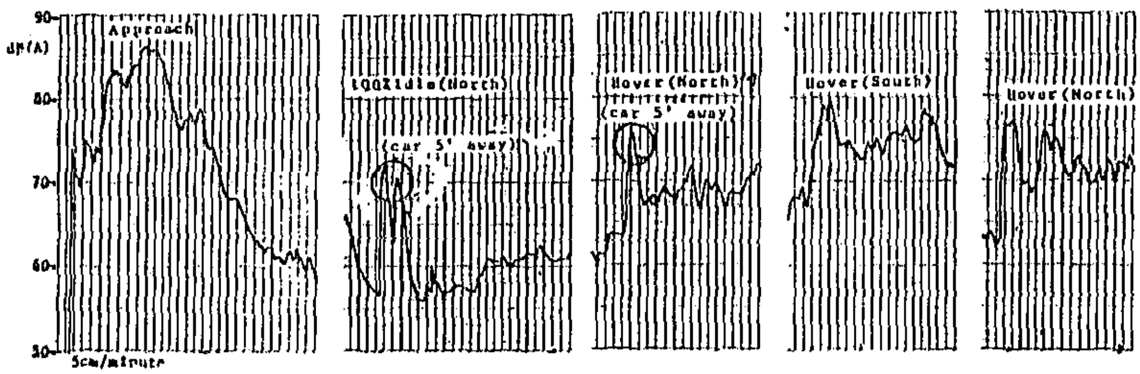


Figure 7.20 Sound Pressure Levels for University of Chicago Hospital Test Station 2

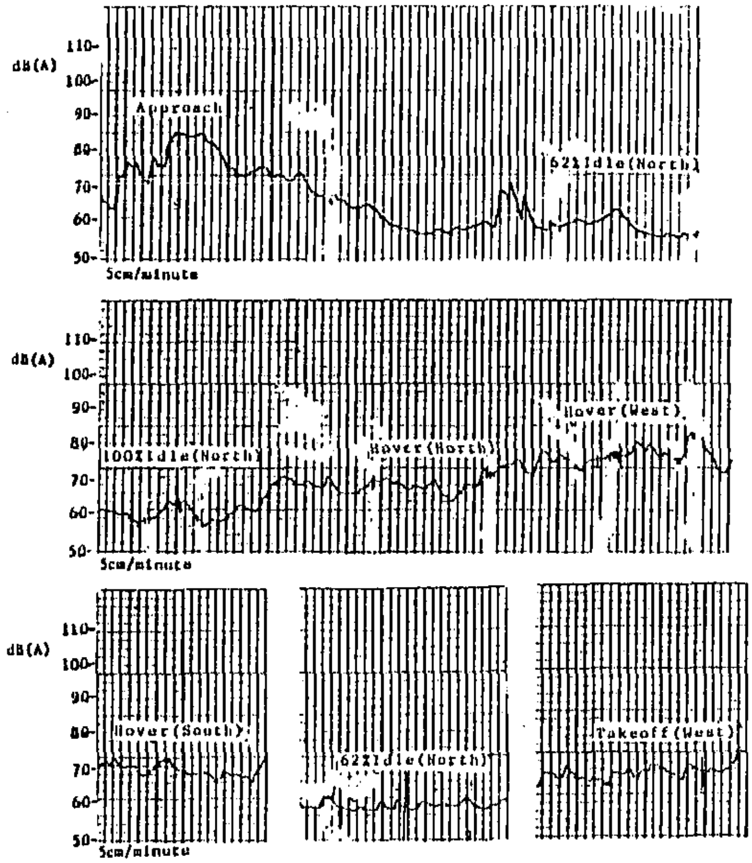


Figure 7.21 Sound Pressure Levels for University of Chicago Hospital Test Station 3

TABLE 7.11 AMBIENT NOISE LEVELS AT UNIVERSITY OF CHICAGO HOSPITAL

Location: University of Chicago Hospital
Date: June 19, 1984 and June 20, 1984
Time: 12:40 p.m.-3:40 p.m., June 19;
1:12 p.m.-2:12 p.m., June 20
Helicopter Model: Aerospatiale Twinstar

Temperature: 73 F, June 19; 72 F, June 20
Dew Point: 38, June 19; 35, June 20
Wind Speed: 10 knots from N (both days)

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient without helicopter test maneuvers.	8:11-9:11 (June 19)	1 Hour	72[1]	72	66	59	55	53	53	52	57	Includes moderate automobile traffic on street 20' away, 4 jet flybys, 3 GA flybys at 3000-5000', several loud shouts 20' away.
Ambient without helicopter test maneuvers.	1:40-2:40 (June 19)	1 Hour	87[2]	83	67	60	56	54	54	53	61	Includes moderate automobile traffic 20' away, 4 GA flybys, truck dumping rocks 600' away.
Ambient without helicopter test maneuvers.	2:40-3:40 (June 19)	1 Hour	78[3]	76	69	59	55	53	52	52	59	Includes moderate automobile traffic 20' away, helo flyby 100' away at 500' altitude, 4 jet flybys at 10,000' altitude, 2 GA flybys at 5000' altitude.
Ambient with helicopter test maneuvers.	1:12-2:12 (June 20)	1 Hour	85[4]	84	79	71	58	54	52	52	67	Includes moderate automobile traffic 20' away, background construction, 2 GA flybys at 500' altitude, whistling 100' away.

All data were recorded with A-frequency weighting and slow response time averaging.
[1] = Lmax from motorcycle 20' away, and Jet flyover at 3000' altitude.
[2] = Lmax from ambulance 20' away.
[3] = Lmax from commercial jet flyover at 10,000' altitude.
[4] = Lmax from test helicopter approach.

TABLE 7.12 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3 UNIVERSITY OF CHICAGO HOSPITAL

Location: University of Chicago Hospital
Date: June 19, 1984; June 20, 1984
Time: 12:40 p.m.-3:40 p.m., June 19;
1:12 p.m.-2:12 p.m., June 20

Temperature: 73 F, June 19; 72 F, June 20
Dew Point: 38, June 19; 35, June 20
Wind Speed: 10 knots from N (both days)

Event	Lmax
Traffic:	
Car horn 30' away.	65
Car 20' away.	60
Same as above.	64
Same as above.	57
Same as above.	66
Same as above.	61
Same as above.	68
Car 50' away.	70
Van 20' away.	60
Motorcycle 20' away.	70
Motorcycle 20' away.	72
Motorcycle 600' away.	61
Truck 30' away.	63
Same as above.	62
Truck 100' away.	60
Dump truck 100' away.	80
Same as above.	61
Ambulance with siren 20' away.	67
School bus 20' away.	63
Same as above.	60
Same as above.	64
Metrobus 20' away.	63
Metrobus accelerating 20' away.	70
Aircraft and In-service Helicopter Traffic:	
Jet overflight at 300' altitude.	72
Jet overflight at 5000' altitude.	73
Jet overflight at 10,000' altitude.	75
Same as above.	78
Same as above.	71
Jet overflight at 20,000' altitude.	61
GA overflight at 5000' altitude.	58
GA overflight at 500' altitude.	73
GA overflight at 2000' altitude.	62
Same as above.	68
GA overflight at 4000' altitude.	63
GA overflight at 6000' altitude.	61
Medium size helicopter 1000' away at 500' altitude.	63
Aerospatiale Twinstar helo approach directly over station at 50' alt.	88
Aerospatiale Twinstar ground idle 500' away.	68
Helicopter Test Maneuvers:	
Approach	85
62% Idle(North)	63
100% Idle(North)	64
Hover(North)	71
Hover(West)	77
Hover(East)	77
Hover(South)	74
62% Idle(North)	61
Takeoff(West)	72

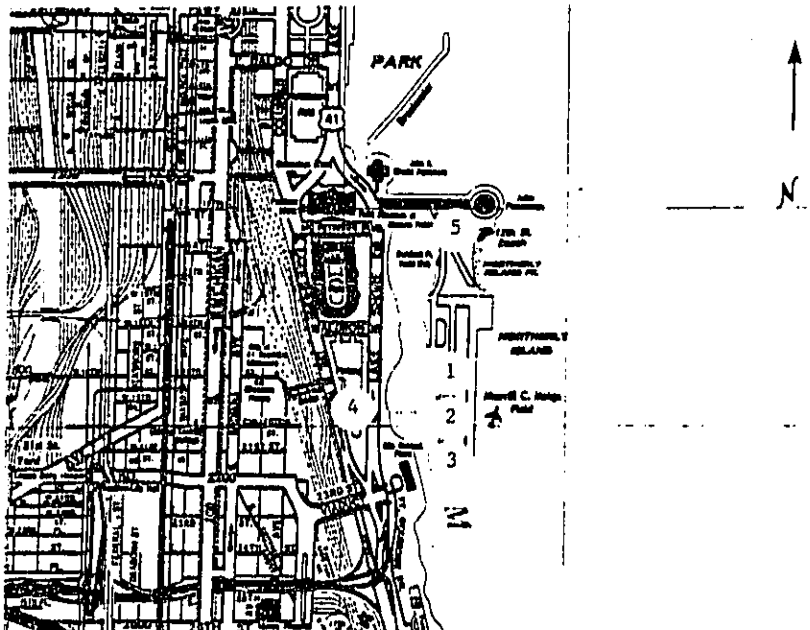
All noise data were recorded with A-frequency weighting and slow response time averaging.

ground idle facing north, to 85 dB(A) for the approach directly over the station. With the exception of the ground idle maneuvers, the Lmax levels measured during the helicopter maneuvers were all higher than the Lmax levels for the street traffic and aircraft overflight events.

7.3 ACTUAL IN-SERVICE HELICOPTER OPERATIONS AT THE PUBLIC USE HELIPAD AT MEIGS FIELD AIRPORT

Noise levels were measured for several actual in-service helicopter operations into and out of the public use helipads at Meigs Field Airport on two different day. On the first day, the three monitoring stations that were used to measure the standardized helicopter test maneuvers at the airport were left in place after the tests to measure noise levels from in-service helicopter operations at the public use helipads. The in-service helicopter operations measured on this day included takeoff, landing, hover and idle maneuvers. On the second day, two monitoring stations were located outside the airport near commonly used approach and departure flight paths to measure noise levels for helicopters in level flight as they approached and departed from the public use helipads. The noise monitoring locations used on both days are shown in Figure 7.22. Locations 1-3 were within the airport. Location 4 was in a large asphalt parking lot at Soldier Field Stadium along the western approach flight paths to the airport. Location 5 was in a grassy area one-quarter mile to the north of the airport runway.

Table 7.13 shows the noise level data obtained from these monitoring locations. No in-service helicopter operations giving rise to noise measureable at location 5 occurred during the time this location was operations. Lmax values measured at



Noise Monitoring Locations:
1. Meigs Field
2. Meigs Field
3. Meigs Field
4. Parking Lot of Soldier Field
5. Park at North End of Meigs Field

7.22 Locations of Public Use Heliport Monitoring Stations

TABLE 7.13 NOISE DATA FOR IN-SERVICE HELICOPTER OPERATIONS AT PUBLIC USE HELIPORT MEIGS FIELD AIRPORT

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Bell 206B approach.	1	40	25	84.2	90.2	90.9
Same as above.	2	50	25	80.7	94.7	86.3
Same as above.	3	50	[1]	[1]	[1]	88
Hughes 500D approach.	1	40	38	83.7	90.4	90.5
Same as above.	2	50	36	81.2	90.7	87.7
Same as above.	3	50	[1]	[1]	[1]	88
Hughes 500D idle(north) 50' away.	1	NA	16	78.2	90.2	78.3
Same as above 200' away.	2	NA	33	67.0	83.1	70.1
Hughes 500D idle(north) 50' away.	1	NA	13	78.5	90.7	79.5
Same as above 200' away.	2	NA	10	68.7	81.4	71.2
Hughes 500D and Bell 206B at ground idle within 25' of each other and 50' away from microphone.	1	NA	16	78.6	91.6	80.1
Same as above 200' away.	2	NA	12	77.5	88.3	78.5
Same two helicopters as above at flight idle 50' away from microphone.	1	NA	14	83.7	95.1	85.7
Hughes 500D flyover.	1	500	23	66.8	80.4	69.6
Same as above.	2	500	27	68.5	80.6	69.9
Bell 206B approach to airport.	4	500	32	66.7	81.7	68.8

All noise data were recorded with A-frequency weighting and slow response time averaging.
* Location numbers refer to location numbers on Figure 7.22.
[1] Noise levels measured with the CNA which is not capable of recording measurement duration, Leq, and SEL for single events.

the other four stations ranged from 69.6 dB(A) for a Hughes 500D helicopter flying at approximately 500 feet altitude to 99.3 dB(A) for a Hughes 500 helicopter idling 50 feet away. Noise levels measured for three overflights at 500 feet altitude registered Lmax values of 69 dB(A), 70 dB(A), and 70 dB(A).

7.4 OTHER ACTUAL IN-SERVICE HELICOPTER OPERATIONS

In addition to the noise level data obtained during in-service helicopter operations at the public use helipads, noise level data were also obtained from actual in-service helicopter operations at four other helipads. Figure 7.23 shows the locations of these four helipads. Three of these were the helipads at Executive Helicopter, WGN Television, and the University of Chicago Hospital test sites. At these three sites, monitoring equipment was left in place to obtain in-service helicopter noise data after the test maneuvers were completed. The fourth helipad was at the Continental Bank on Canal Street. The noise monitoring station at this helipad was set up on a concrete sidewalk at the intersection of two downtown streets. There was light to moderate automobile and truck traffic on both streets. Land use in the immediate area of this location is primarily light manufacturing. A large railroad yard lies immediately to the east of the helipad. A five-minute background ambient noise sample, during which there were no helicopter operations showed a Leq level of 68.3 dB(A) with Lmax of 78.6 dB(A).

Table 7.14 shows the noise data obtained from all of the noise monitoring locations. Lmax values recorded ranged between 55 dB(A) for an Aerospatiale Twinstar engine cool-down 588 feet away to 90.1 dB(A) for a Bell 206B flyover at 40 feet altitude and a lateral ground distance of 30 feet.

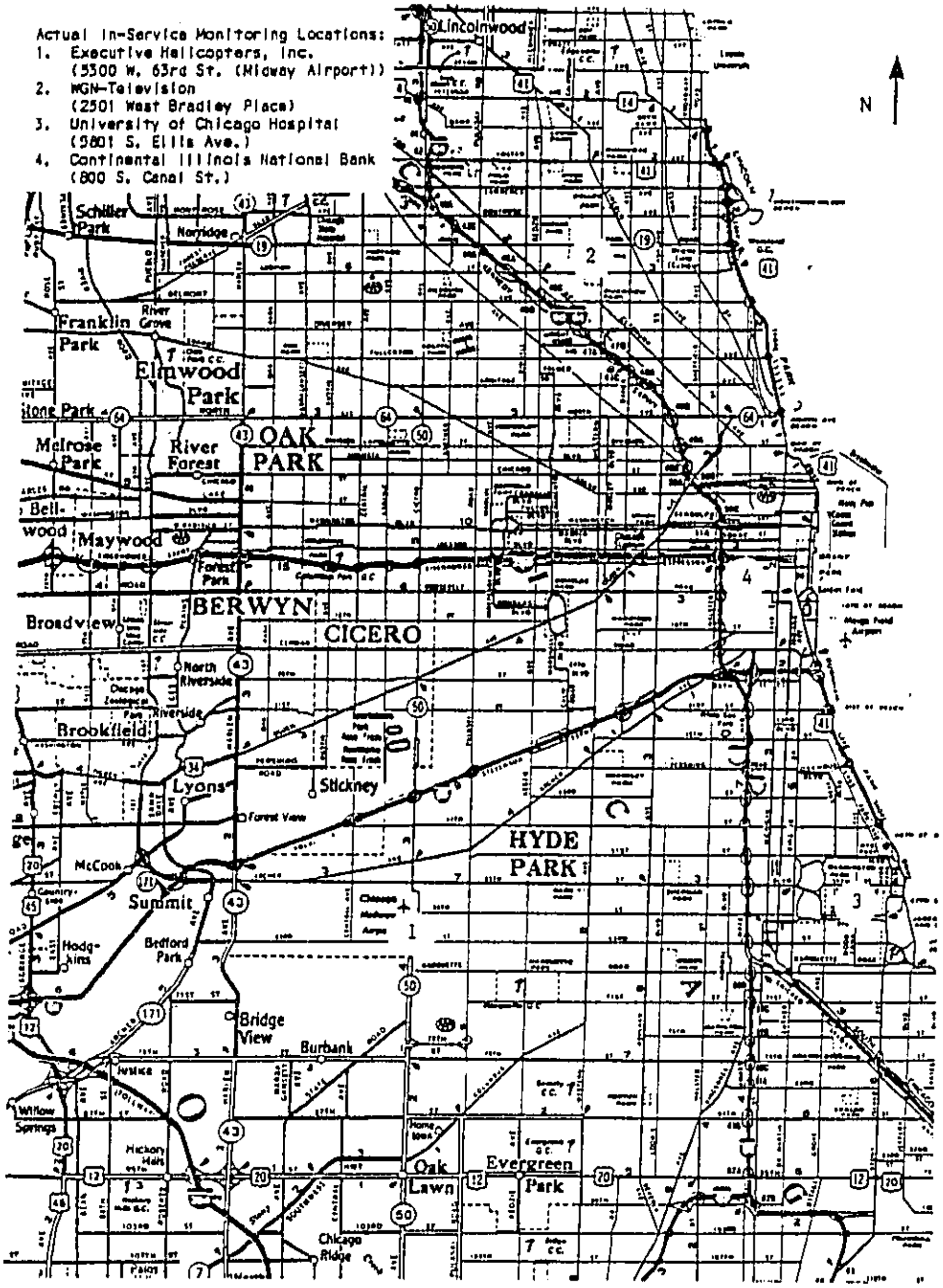


Figure 7.23 Locations of Actual In-Service Operations Monitoring Stations

TABLE 7.14 NOISE DATA FOR ACTUAL IN-SERVICE HELICOPTER OPERATIONS

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Bell 206B approach from east 20' east & parallel to array.	1 (Station 1)	40	25	80.7	84.2	85.4
Bell 206B takeoff to west 20' south and parallel to array.	1 (Station 1)	30	13	82.5	83.6	87.6
Same as above.	1 (Station 2)	40	14	83.0	95.1	90.1
Same as above.	1 (Station 3)	30	[1]	[1]	[1]	85
Bell 206B Flyby 500' away.	1 (Station 1)	500	12	68.1	78.0	68.2
Same as above.	1 (Station 2)	500	14	65.2	76.7	68.8
Same as above.	1 (Station 3)	500	[1]	[1]	[1]	69
Bell 206B approach from east.	1 (Station 1)	40	14	83.6	95.1	90.1
Same as above.	1 (Station 2)	40	20	67.3	80.3	74.8
Same as above.	1 (Station 3)	40	[1]	[1]	[1]	71
Enstrom F28 warmup 450' away.	1 (Station 3)	NA	[1]	[1]	[1]	65
Enstrom F28 hovering 450' away.	1 (Station 3)	30	[1]	[1]	[1]	72
Same as above.	1 (Station 3)	30	[1]	[1]	[1]	60

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figure 7.23 for station locations.
[1] Noise levels measured with the CNA which is not capable of recording measurement duration, Leq, and SEL for single-event.

(continued on next page)

TABLE 7.14 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Bell 206B approach.	1 (Station 3)	150	[1]	[1]	[1]	83
Bell 206B Idle (East) 450' away.	1 (Station 3)	NA	[1]	[1]	[1]	81
Enstrom F28 flyby 1000' away.	2 (Station 1)	500	8	53.4	62.4	55.8
Same as above but 800' away.	2 (Station 1)	500	15	57.0	68.8	62.8
Same as above 1000' away.	2 (Station 2)	500	20	58.2	60.1	55.6
Enstrom F28 approach from south over station.	2 (Station 3)	50	[1]	[1]	[1]	80
Enstrom F28 takeoff to north 450' away.	2 (Station 3)	50	[1]	[1]	[1]	78
Enstrom F28 flyby 500' away.	2 (Staton 3)	500	[1]	[1]	[1]	70
Medium helicopter flyover 1000' away.	3 (Station 3)	500	[1]	[1]	[1]	63
Aerospatiale Twinstar approach directly over station.	3 (Station 3)	50	[1]	[1]	[1]	80
Aerospatiale Twinstar 100% Idle(North) 100' away.	3 (Station 2)	NA	18	74.3	86.8	77.6
Same as above 588' away.	3 (Station 3)	NA	[1]	[1]	[1]	68
Aerospatiale Twinstar cooldown 588' away.	3 (Station 3)	NA	[1]	[1]	[1]	66
Bell 206B 100% Idle(East).	4	NA	30	74.3	88.0	78.0
Bell 206B takeoff (East).	4	NA	18	80.0	92.7	83.3

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figure 7.23 for station locations.
[1] Noise levels measured with CNA which is not capable
of recording measurement duration, Leq, and SEL for single-event.

CHAPTER 8

RESULTS OF THE HELICOPTER NOISE SURVEY IN NEW ORLEANS, LOUISIANA

This chapter presents the results of the helicopter noise survey performed in New Orleans, Louisiana. The chapter is divided into three sections: Section 8.1 presents a general overview of helicopter operations in the New Orleans area; Section 8.2 presents noise measurement data obtained from standardized helicopter maneuvers and land use characteristics at three helipad test sites; and Section 8.3 presents noise measurement data obtained from monitoring actual in-service helicopter operations in the vicinity of three helipads in New Orleans.

8.1 OVERVIEW OF HELICOPTER OPERATIONS IN NEW ORLEANS

The Louisiana coastline has one of the highest concentrations of helicopter operations in the country. Many of the operations originate in the New Orleans metropolitan area and involve several helicopter companies that are based there. The majority of the helicopter operations in New Orleans involve service to the oil rigs located off the coast of Louisiana in the Gulf of Mexico: helicopters are leased by oil companies to ferry drilling crews and equipment back and forth from the oil rigs. Other helicopter operations include FAR 135 charter services, executive personnel transport, and aerial photography services.

Complaints of noise from helicopter operations in the New Orleans area are not frequent. According to the FAA Baton Rouge Field Office, most of the helicopter-related noise complaints received, estimated at between three and four a month, came from a small residential neighborhood located south of the Lakefront Airport which is located on the Lake Ponchartrain shore in the northern part of the city.

Many of the helicopter operations at the Lakefront Airport involve flying over this neighborhood at an altitude of between 300 and 500 feet. (Section 8.3 contains noise level data obtained from several flights over this neighborhood.) In an effort to minimize the noise impact from helicopter operations on residential neighborhoods near the airport, the FAA and the Lakefront Airport Manager have established recommended noise abatement procedures for helicopter pilots. These procedures require that:

- All helicopter pilots maintain an altitude of at least 300 feet before beginning their descent into the airport;
- Helicopter pilots depart and approach the airport from the east and west over Lake Ponchartrain whenever possible;
- Pilots fly over major highways and waterways whenever possible;
- Pilots use operational procedures recommended in the "Fly Neighborly Program" ["Fly Neighborly Program", Helicopter Association International, February 1982].

According to operations data obtained from helicopter operators and the FAA, there are currently 9 operational helipad facilities located in the New Orleans area. Figure 8.1 shows their locations. Five of the facilities are located at Lakefront Airport. Four of these are operated by private helicopter companies: Pumpkin Helicopter, Inc. (Location 1), Chevron Oil (Location 2), Sue West Airways, Inc. (Location 5) and Jet America (Location 6). The fifth is operated by the Louisiana National Guard (Location 3). Noise measurements for the standardized helicopter noise test maneuvers were obtained at Locations 1 and 2.

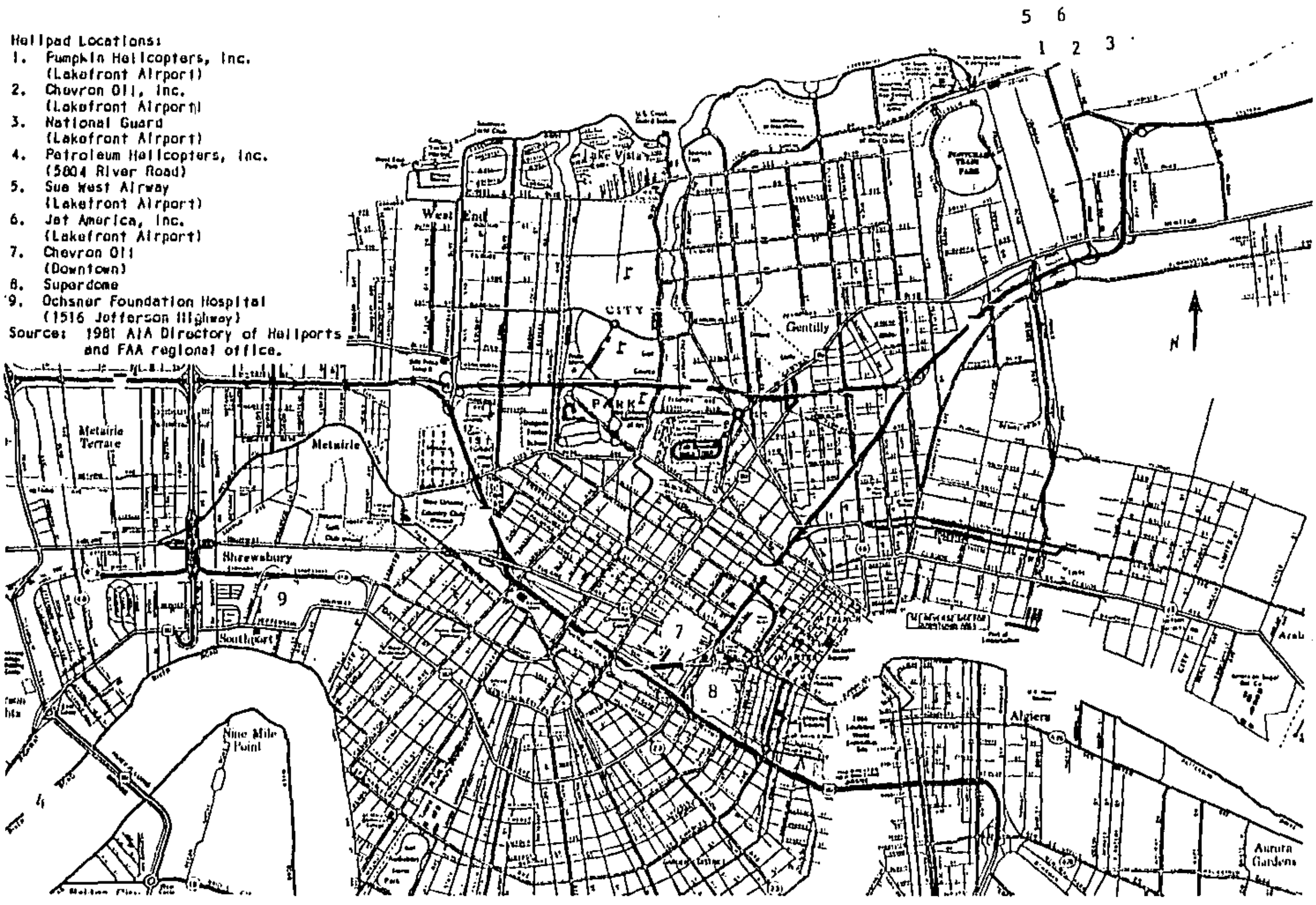


Figure 8.1 Locations of Pad In New Orleans

The Pumpkin Helicopter Inc. operation is a multi-helipad facility (Location 1) located adjacent to the south taxiway of the airport. The helipads there are used primarily between the morning hours of 7:00 a.m. to 9:00 a.m. and the evening hours of 4:00 p.m. to 8:00 p.m. for government-related charter operations (e.g. aerial photography for the U.S Geological Survey) and private charter use. There are normally between 15 and 20 operations per day at this facility.

The Chevron Oil helipad (Location 2) is a maintenance facility for its fleet of helicopters. It is situated on the east side of the south taxiway. The number of operations at this facility varies from between four and ten per day, and are generally flight tests of helicopters after maintenance has been completed. In addition to the helipad at their maintenance facility, Chevron Oil also has a helipad located at their downtown office building. Operations at this helipad are primarily for executive personnel transport and average fewer than two per day.

The National Guard helipad base and maintenance facility (Location 3) is on the east side of the south taxiway adjacent to Chevron Oil and supports a fleet of military Bell 206 and Bell 214 helicopters. Helicopter operations at this facility are mainly for pilot training and military exercises.

Noise measurements were obtained for the standardized helicopter operations at Locations 1 and 2. There are two other airport helipads (Location 5 and 6) where noise measurements were not obtained: The Sue West Airways (Location 5) helipad is on the western perimeter of the Airport. Operations at this helipad are primarily for FAR 135 charter operations and other specialized services. The number of operations averages between two and six per day. Jet America, Inc. (Location 6) also performs FAR 135 charter operations and specialized services such as covering news stories for a local television station. The number of operations averages approximately six per day.

There are also several helipads located in other parts of the metropolitan area. The city of New Orleans operates a public use helipad in the parking lot of the Superdome (Location 8) in the central business district. It is intended for transient helicopter operations and use of the helipad is not restricted. However, prior permission is required. The frequency of operations at the Superdome helipad is fairly low, averaging less than two per day. Two helipad facilities, operated by Petroleum Helicopters, Inc. and the Ochsner Foundation Hospital are located outside of the New Orleans City limits in Jefferson Parish and Shrewsbury. Petroleum Helicopters, Inc. (Location 4) is a street level multi-helipad facility whose operations consist primarily of transporting drilling crews and equipment to and from oil rigs in the Gulf of Mexico. Most of the operations at this facility occur between the morning hours of 7:00 a.m. and 9:00 a.m. and the evening hours of 4:00 p.m. and 6:00 p.m. The frequency of operations averages between 20 and 25 per day. Noise measurements were obtained for the standardized helicopter operations at this location.

The Ochsner Foundation Hospital helipad (Location 9) is at street level in the hospital parking lot. It is used for emergency ambulance service and transporting patients between area hospitals. The frequency of operations at this helipad varies, but generally averages around two per day.

8.2 STANDARDIZED MANEUVER TESTS

Two helicopter models were used in standardized maneuver tests in New Orleans: a Bell 206B and a Bell 206L. Manufacturers' specifications for these helicopters are shown in Appendix B.

The tests were conducted at three helipads. Two of the helipads (Pumpkin Helicopter, Inc. and Chevron Oil,) were located at Lakefront Airport. The third helipad (Petroleum Helicopter, Inc.) was located in Jefferson Parish, four miles southwest of New Orleans. Sections 8.2.1 through 8.2.3 describe how the noise monitoring stations were placed at each site, land use in the vicinity of each site, the helicopter test maneuvers, and the noise measurement data obtained.

8.2.1 Pumpkin Helicopter, Inc.

Pumpkin Helicopter, Inc. operates five Bell 206Ls and one Bell 206B helicopter from its facilities at Lakefront Airport (Location 1 in Figure 4.1). The helicopters use six helipads located 45 feet apart in a line running north and south on the west taxiway of the airport. Figure 8.2 shows the land use in the vicinity of the airport.

The airport is located on a peninsula extending into Lake Ponchartrain with the lake bordering the airport to the west, north and east. A park and open area are located southwest of the airport. A heavy industrial area located along the Industrial Canal running into Lake Ponchartrain is located south of the helipad. To the east of the industrial area and south of the airport is a detached single-family residential neighborhood. This residential neighborhood is where most of the helicopter-related noise complaints originate.

Three noise monitoring stations were set up in a line extending north from the helipad at distances of 210 feet, 374 feet, and 531 feet from the northernmost helipad (Helipad #1). Figure 8.3 shows the locations of the noise monitoring stations in relation to the helipads, as well as the flight paths used by the helicopters on takeoffs. (Approach maneuvers were not performed

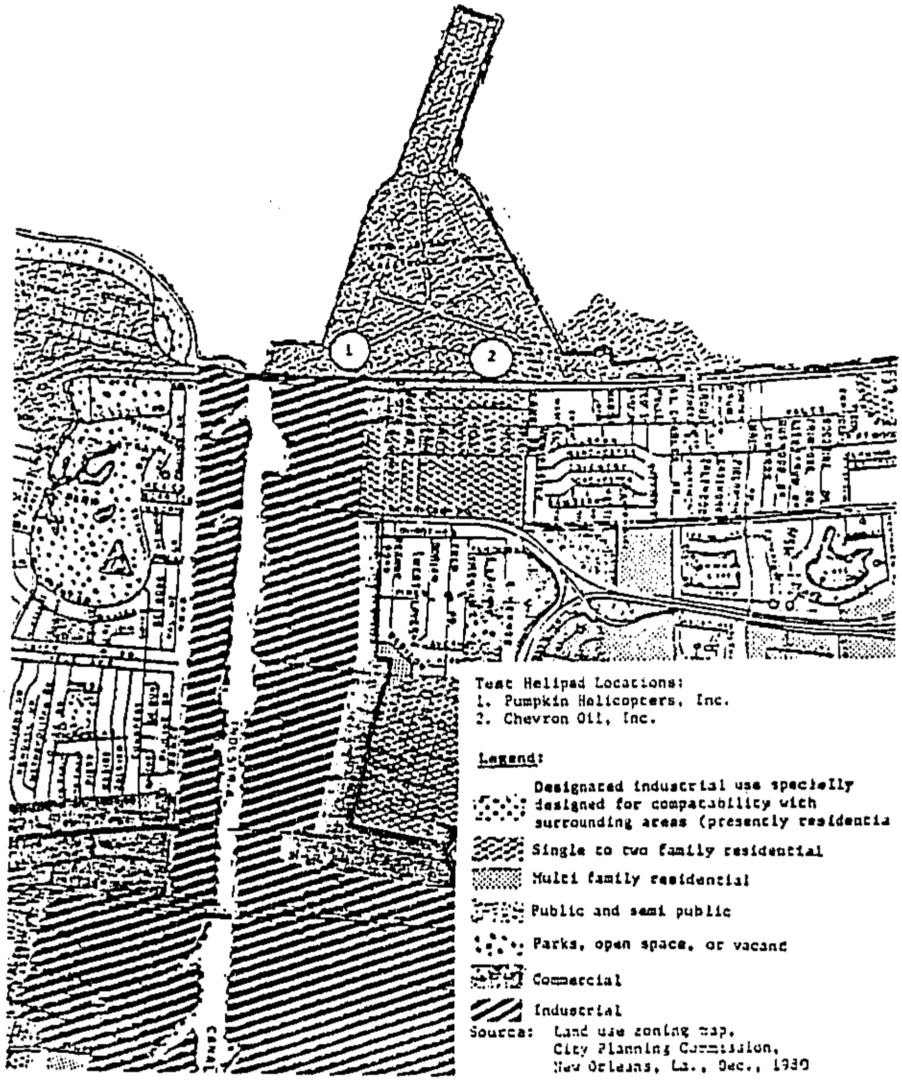


Figure 8.2 Land Use In the Vicinity of Lakefront Airport

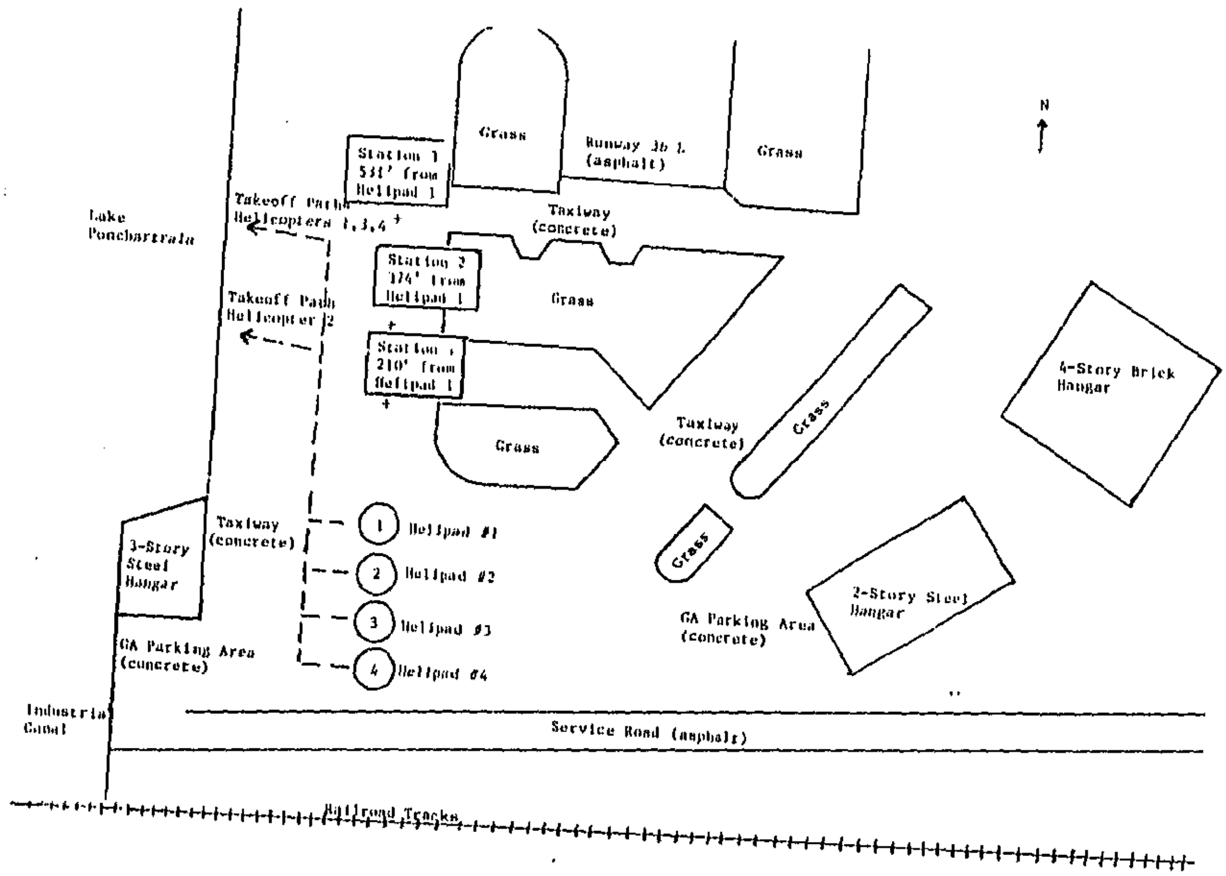


Figure 8.3 Site Schematic for Pumkin Helicopters Inc. Test Site

due to the limited time of the helicopter operator.) All of the noise monitoring stations were located on the concrete taxiway adjacent to a grassy area. The end of one of the airport runways was located approximately 300 feet to the east of Station 3.

Because the helipads are located on the taxiway and within 300 feet of the airport runway, aircraft taxiing and landing operations were present during some of the noise sample periods. Aircraft operations were the principal source of background ambient noise. A railroad track running east and west, located approximately 900 feet south of Station 1, had occasional train traffic.

Noise level data were recorded for several idle and takeoff maneuvers of four Bell 206L helicopters. The maneuvers performed by each of these helicopters are shown below in the order that they occurred. The helicopters are labeled #1 through #4.

Helicopter #1:

1. 100% flat pitch, idle, West;
2. Takeoff, to West.

Helicopter #2:

1. 62% flat pitch, idle, West;
2. 100% flat pitch, idle, West;
3. Takeoff, to West.

Helicopter #3:

1. 62 % flat pitch, idle, West;
2. 100% flat pitch, idle, West;
3. Takeoff, to West.

Helicopter #4:

1. 62% flat pitch, idle, West;
2. Takeoff, to north.

Table 8.1 shows the noise levels recorded from the helicopter test maneuvers at the three measurement stations. Aircraft operations on the nearby runway prevented the helicopter from performing takeoffs directly over the noise measurement array. (For this reason, the takeoff data in this series of tests are not directly comparable to other takeoff data.) Helicopters #1, #3, and #4 took off to the north, 50 feet west of the noise measurement array, and turned west near Station 3. This explains the similar Lmax levels recorded at the three stations. Helicopter #2 took off to the north, 50 feet west of the noise measurement array, and turned west between Stations 1 and 2. This resulted in a Lmax level recorded at Station 2 of 7.2 dB(A) lower than Station 1. The Lmax levels of Helicopters #2 and #3 at the three measurement stations were 4 dB(A) to 5 dB(A) lower during 62% flat pitch idle than during 100% flat pitch idle. (Comparison noise data from ground and takeoff idle for Helicopters #1 and #4 are not available.) The charts of SPL measured at Stations 1, 2, and 3 during the tests are shown in Figures 8.4, 8.5, and 8.6, respectively. Charts for Helicopters #1 and #2 are not available for Station 1 due to a malfunction of the graphic level recorder.

TABLE 8.1 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT PUMPKIN HELICOPTERS, INC.

Location: Pumpkin Helicopters, Inc.
Date: August 6, 1984
Time: 7:30 a.m.
Helicopter Model: Bell 206L (all 4 test helicopters)

Temperature: 81 F
Dew Point: 73
Wind Speed: 3 – 8 knots from NE

Station	Dist. From Pad (ft.)	Helicopter 1: Bell 206L — 100% Idle (West) Time (sec.)	Leq	SEL	Lmax	Takeoff (North) [1][+] Time (sec.)	Leq	SEL	Lmax	Dist. From Pad (ft.)	Helicopter 2: Bell 206L — 62% Idle (West) Time (sec.)	Leq	SEL	Lmax	100% Idle (West) Time (sec.)	Leq	SEL	Lmax	Takeoff (West)[1][+] Time (sec.)	Leq	SEL	Lmax
1	210	14	75.4	76.5	76.5	27	87.2	101.5	81.4	255	22	71.0	84.3	72.2	13	77.2	88.3	78.0	13	85.2	86.3	80.8
2	374	12	71.0	82.4	73.7	20	83.1	87.6	88.8	418	23	68.0	81.8	68.8	12	73.0	83.7	74.4	13	78.1	80.2	83.4
3	531				*				*	576				67				71				82

Station	Dist. From Pad (ft.)	Helicopter 3: Bell 206L — 62% Idle (West) Time (sec.)	Leq	SEL	Lmax	100% Idle (West) Time (sec.)	Leq	SEL	Lmax	Takeoff(North)[1][+] Time (sec.)	Leq	SEL	Lmax	Dist. From Pad (ft.)	Helicopter 4: Bell 206L — 62% Idle (West) Time (sec.)	Leq	SEL	Lmax	Takeoff(North)[2][+] Time (sec.)	Leq	SEL	Lmax
1	300	30	69.0	84.3	71.0	15	74.4	86.1	76.0	–	–	–	84.5[3]	345	20	71.2	85.8	72.3	10	83.4	86.2	90.0
2	404	32	63.2	78.2	60.1	15	60.6	81.3	70.5	30	82.2	96.1	82.0	500	20	68.3	82.0	60.4	16	81.8	84.4	88.0
3	521				62				67				80	666				67				80

All noise data recorded with A-frequency weighting and slow response time averaging.
[1]=Helicopter estimated at 100' altitude directly over Station 3; 80' altitude directly over Station 2 (visual judgement).
[2]=Helicopter estimated at 120' altitude directly over Station 3; 80' altitude as it passed west of Station 3 (visual judgement).
[3]=Lmax valve obtained from SPL graph.
[+]=Noise data not directly comparable with corresponding data in other tests. See text.

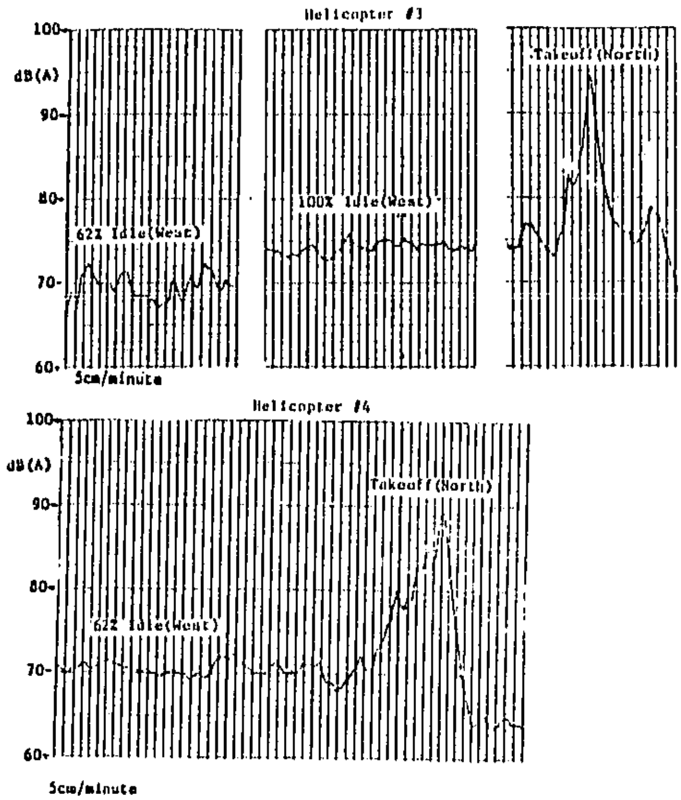


Figure 8.4 Sound Pressure Levels for Pumpkin Helicopters Inc. Test - Station 1

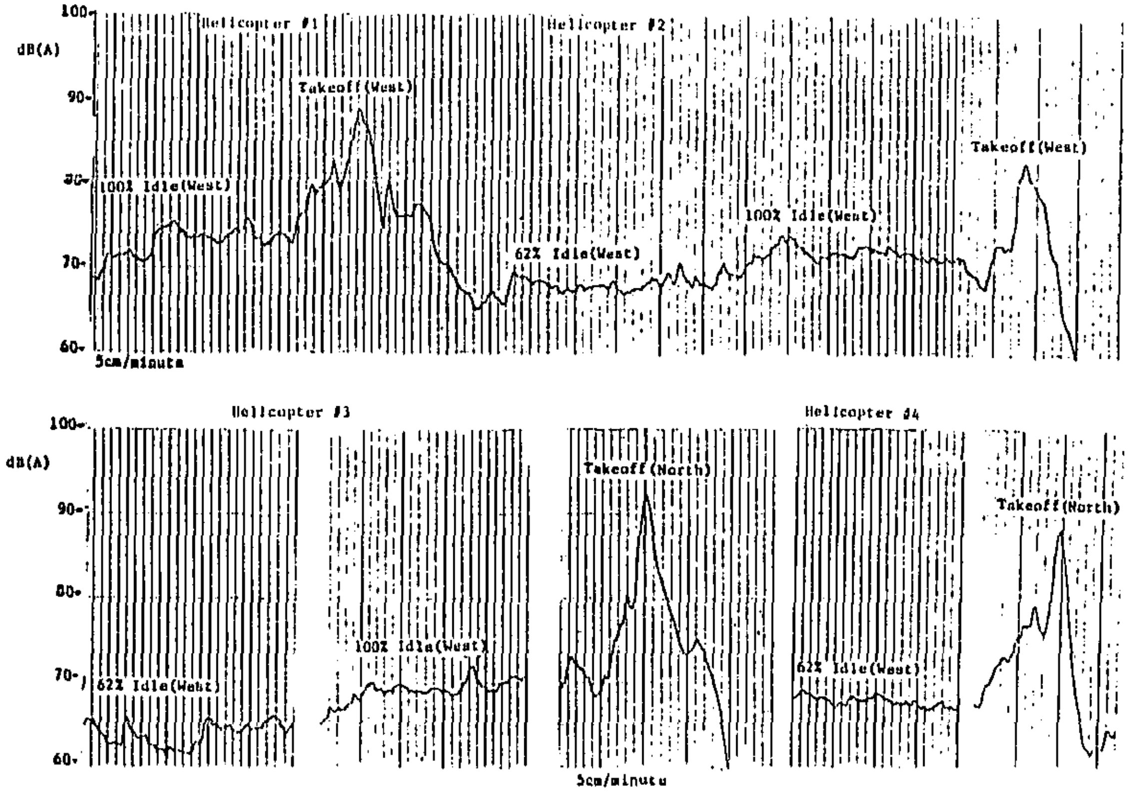


Figure 8.5 Sound Pressure Levels for Pumpkin Helicopters Inc. Test - Station 2

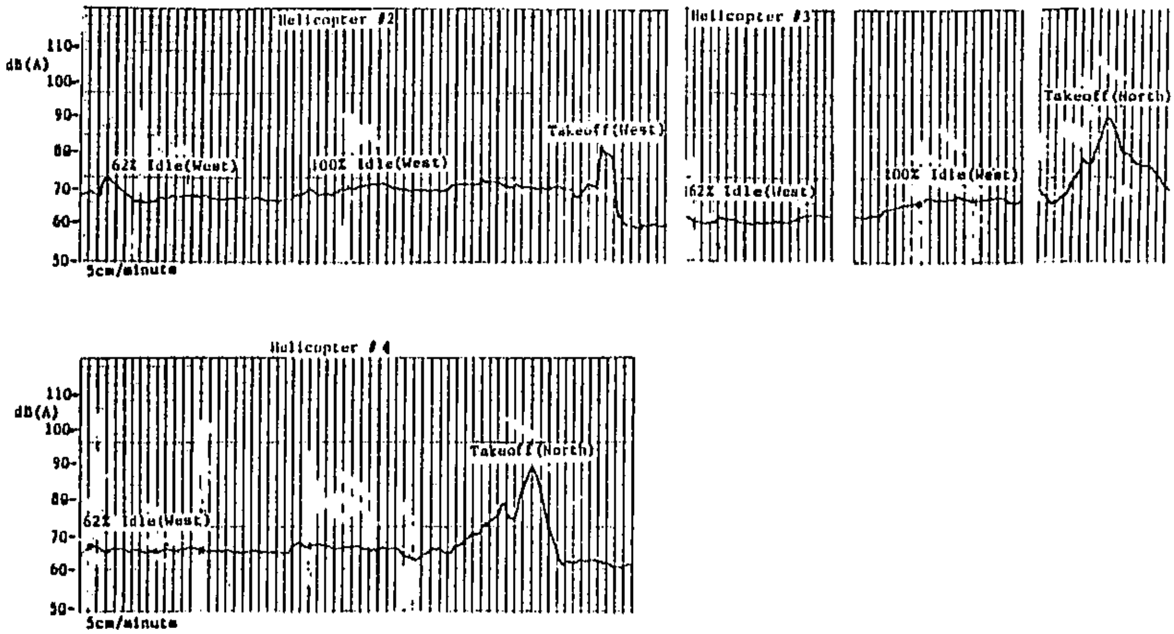


Figure 8.6 Sound Pressure Levels for Pumpkin Helicopters Inc. Test - Station 3

Table 8.2 shows ambient noise data recorded at Station 3 for three consecutive one-hour sample periods. The first ambient noise sample period includes the helicopter test maneuvers while the other two do not. The helicopter test maneuvers lasted for approximately 29 minutes. The data indicate Leq levels 15 dB(A) to 24 dB(A) higher in the sample period that included the helicopter tests than in the two sample periods that do not include the tests. The sample period with the helicopter tests, however, also includes a general aviation jet takeoff 200 feet away that registered 112 dB(A). This contributed to a noise level exceeding 111 dB(A)for one-tenth of a percent of the sample period. All three of the sample periods included some GA jet and propeller aircraft operations. Due to the varying number of GA aircraft operations during the sample periods it is not possible to accurately determine the contribution of noise from the helicopter operations to the ambient noise levels.

Table 8.3 shows Lmax values recorded at Station 3 during the ambient noise sample periods for selected intrusive noise incidents (primarily GA aircraft operations), and the Lmax values recorded during the helicopter test maneuvers. Lmax values recorded during GA jet aircraft operations ranged from 62 dB(A) for a jet flyover at approximately 1000 feet altitude to 112 dB(A) from a GA jet takeoff approximately 200 feet away. Lmax values recorded from GA propeller aircraft operations ranged from 65 dB(A) for a flyover at approximately 500 feet altitude to 87 dB(A) for a takeoff approximately 500 feet away. By comparison, Lmax values for the helicopter test maneuvers ranged from 62 dB(A) for a Bell 206L during ground idle 621 feet away to 90 dB(A) for a Bell 206L takeoff at approximately 70 feet altitude overhead.

TABLE 8.2 AMBIENT NOISE LEVELS AT PUMPKIN HELICOPTERS, INC.

Location: Pumpkin Helicopters, Inc.
Date: August 6, 1984
Time: 7:45 a.m.-10:45 a.m.

Temperature: 81 F
Dew Point: 73
Wind Speed: 3 - 6 knots from NE

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient with helicopter test maneuvers.	7:45-8:45	1 Hour	112[1]	111	87	77	64	57	54	54	86	Includes moderate GA and jet aircraft traffic, and in-service Bell 206B approach.
Ambient without helicopter test maneuvers.	8:45-9:45	1 Hour	91[2]	88	82	73	58	53	50	50	70	Includes 2 Bell 206B takeoffs, 206B idle, light GA activity, and 1 jet landing.
Ambient without helicopter test maneuvers.	9:45-10:45	1 Hour	92[3]	90	76	60	52	49	47	46	61	Includes light GA activity at airport, 1 helicopter landing 2000' away, and 2 jet flyovers at 1000' altitude.

All data were recorded with A-frequency weighting and slow response time averaging.
[1] Lmax recorded from 2-engine jet takeoff 200' away.
[2] Lmax recorded from Bell 206B takeoff.
[3] Lmax recorded from general aviation aircraft warm-up 100' away.

TABLE 8.3 SELECTED COMPARISION OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3
PUMPKIN HELICOPTERS, INC.

Location: Pumpkin Helicopters, Inc.
Date: August 6, 1984
Time: 7:45 a.m.-10:45 a.m.

Temperature: 81 F
Dew Point: 73
Wind Speed: 3 - 8 knots from NE

Event	Lmax
Jet Aircraft Activity:	
Takeoff 200' away.	112
Landing 200' away.	88
Landing 300' away.	81
Flyover at 1000' altitude.	82
Flyover at 1000' altitude.	84
GA Aircraft Activity:	
Taxi 300' away.	83
Taxi 300' away.	70
Takeoff 300' away.	81
Takeoff 1000' away.	85
Takeoff 500' away.	74
Takeoff 500' away.	67
Takeoff 500' away.	70
Landing 200' away.	77
Landing 500' away.	78
Warm-up 30' away.	74
Warm-up 500' away.	80
Warm-up 100' away.	82
Flyover 500' overhead.	85
Flyover 300' overhead.	81
In-service Helicopter Maneuvers:	
Bell 206B approach from north 350' away.	83
Medium helicopter landing 2000' away.	63
Bell 206B hover(West) 348' away.	69
Bell 206B 62% ground idle 500' away.	63
Bell 206B 62% ground idle 500' away.	68
Bell 206L ground idle 880' away.	67
Bell 206B takeoff 50' west of station at 50' altitude.	89
Bell 206B takeoff 50' west of station at 50' altitude.	91
Miscellaneous:	
Lawn mower 500' away.	58
Bird chirping 100' away.	51
Bird chirping 50' away.	53
Hammering 1500' away.	50
Dump truck 500' away.	58
Cars passing 1000' away.	56
Helicopter Test Maneuvers:	
Helicopter 2: Bell 206L	
62% Idle(West)	67
100% Idle(West)	71
Takeoff(West)	82
Helicopter 3: Bell 206L	
62% Idle(West)	62
100% Idle(West)	67
Takeoff(North)	74
Helicopter 4: Bell 206L	
62% Idle(West)	66
Takeoff(North)	90

All noise data were recorded with A-frequency weighting and slow response time averaging.

8.2.2 Chevron Oil, Inc.

The Chevron Oil, Inc. helicopter maintenance facility is located near the south taxiway of Lakefront Airport (Location 2 in Figure 8.1). Land use characteristics in the vicinity of the airport are shown in Figure 8.2 and were described in Section 8.2.1. A residential neighborhood is located directly south of the Chevron Oil maintenance facility.

Normal procedure at Chevron Oil is for departing helicopters to use a helipad on the taxiway for engine warm-ups and then to hover-taxi to a grassy area across the runway before getting clearance from the airport control tower to takeoff. The standardized maneuver tests were performed at the south taxiway helipad.

Three noise monitoring stations were set up in a straight line 150 feet, 300 feet, and 450 feet west from the helipad, respectively. Figure 8.7 shows a site schematic of the noise monitoring locations and surrounding area. The three noise monitoring stations were located on the concrete taxiway approximately 75 feet north of the Chevron Oil hangar. Some GA aircraft were parked between the hangar and Stations 2 and 3. Background ambient noise levels were in the low 70 dB(A) range with intrusive noise sources coming primarily from GA aircraft activity and in-service helicopter operations at the Louisiana National Guard helicopter base adjacent to the Chevron Oil facility.

The helicopter pilot at Chevron Oil, using a Bell 206B Jetranger III, performed the following maneuvers in the order listed:

1. 100% flat pitch, idle, North;
2. Hover, north;

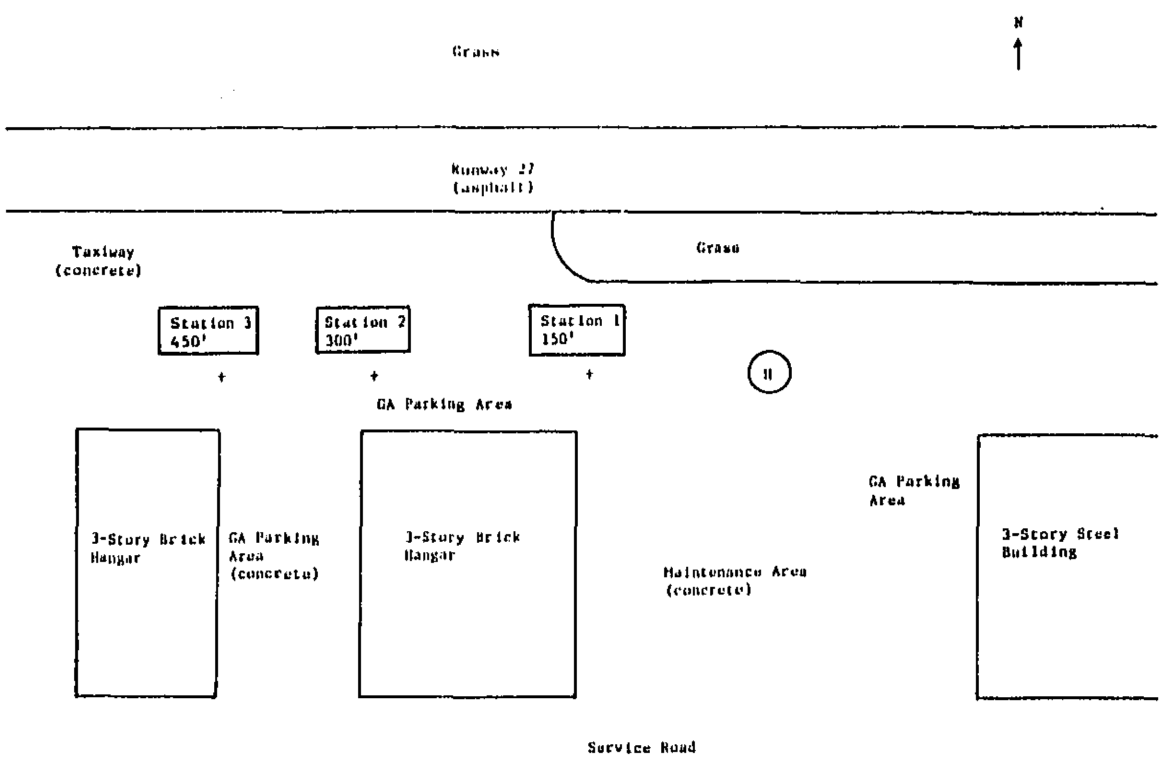


Figure 8.7 Site Schematic for Chevron Oil Test Site

3. Hover, east;
4. 100% flat pitch, idle, South;
5. Hover, south;
6. Hover, west;
7. 100% flat pitch, idle, West;
8. 62% flat pitch, idle, West.

Table 8.4 shows the noise levels recorded during the helicopter test maneuvers at the three measurement stations. Takeoff and landing maneuvers were not performed because the pilot was not permitted to takeoff or land at the taxiway helipad. The takeoff idle maneuvers performed facing north and south (with the helicopter perpendicular to the noise measurement array) produced almost identical Lmax and Leq levels. The 100% flat pitch, idle facing west, however, produced Lmax values from 2 dB(A) to 5 dB(A) lower than for the 100% flat pitch, idle maneuvers facing north and south. The Lmax values recorded from the hover maneuvers performed facing north and south were also very similar, with less than a 2 dB(A) difference between them. The Lmax levels for the hover facing east were 7 dB(A) higher than for the hover facing west. The SPL charts for Stations 1, 2 and 3 are shown in Figure 8.8, 8.9, and 8.10, respectively.

Table 8.5 shows ambient noise data obtained at Station 3 during four one-hour sample periods. Two sample periods, one with the helicopter test maneuvers and one without, were on the day of the standardized helicopter tests. Two other sample periods, without helicopter tests, were two days later with Station 3 at the same location as in the previous sample periods. The helicopter test maneuvers lasted approximately 11 minutes.

Station 3 was located on the airport taxiway within 200 feet of one of the airport runways. Consequently, there were several GA fixed-wing aircraft operations occurring nearby during all of

TABLE B.4 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT CHEVRON OIL, INC.

Location: Chevron Oil, Inc.
Date: August 6,1984
Time: 11:55 a.m.
Helicopter Model: Bell 206B Jetranger III

Temperature: 88 F
Dew Point: 80
Wind Speed: 3 - 6 knots from N

Station	Dist. From Pad (ft.)	100% Idle (North)				Hover (North)				Hover (East)				100% Idle (South)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	150	28	84.5	99.0	93.0	28	90.4	102.5	90.0	28	86.0	100.4	90.1	28	82.0	97.5	83.6
2	300	27	74.5	88.6	78.7	26	80.4	94.5	83.2	28	80.3	94.7	84.4	28	74.6	89.1	78.6
3	450				78				78				81				73

Station	Dist. From Pad (ft.)	Hover (South)				Hover (West)				100% Idle West				60% Idle (West)			
		Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax	Time (sec.)	Leq	SEL	Lmax
1	150	30	87.0	101.7	90.0	31	80.0	95.7	81.8	30	78.2	92.9	79.0	32	73.2	88.2	75.5
2	300	29	78.5	93.1	81.5	32	75.0	90.0	78.6	31	70.8	85.4	72.5	32	64.9	79.9	67.0
3	450				78				74				70				63

All noise data recorded with A-frequency weighting and slow response time averaging.

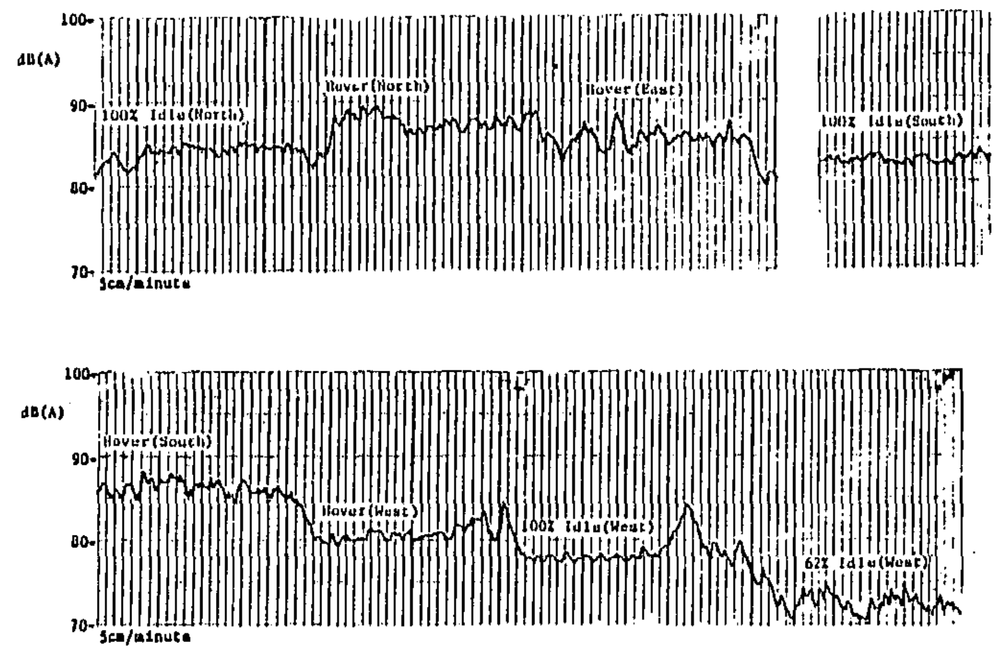


Figure 8.8 Sound Pressure Levels for Chevron Oil Test - Station 1

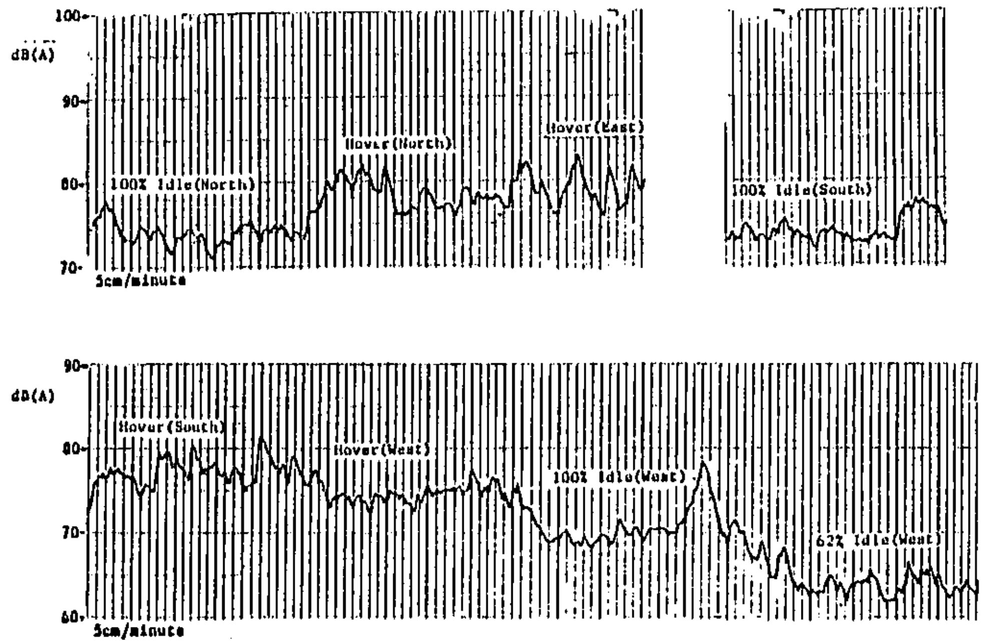


Figure 8.9 Sound Pressure Levels for Chevron Oil Test - Station 2

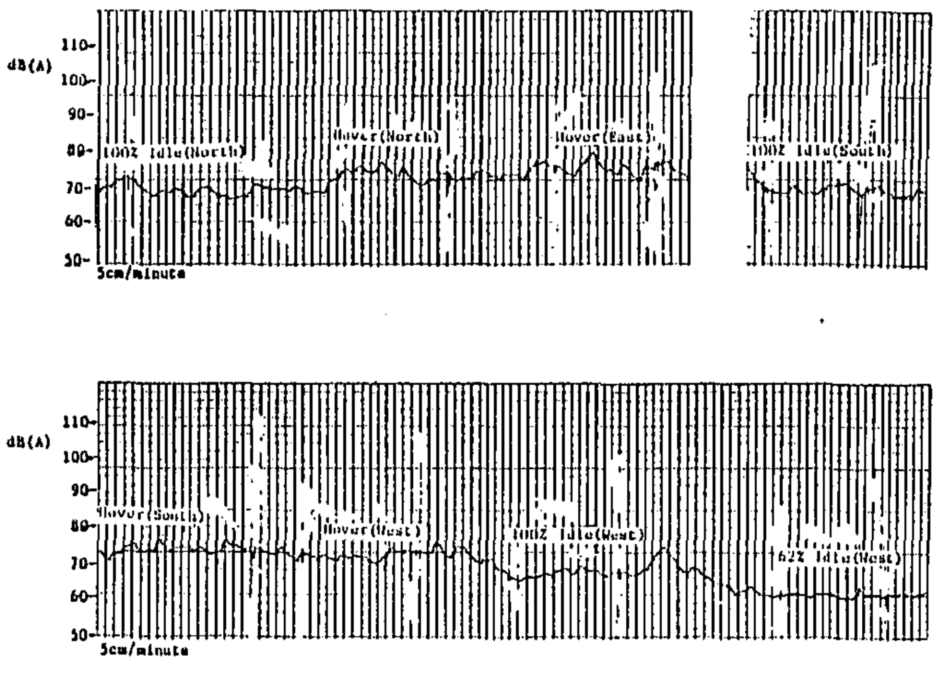


Figure 8.10 Sound Pressure Levels for Chevron Oil Test - Station 3

TABLE 8.5 AMBIENT NOISE LEVELS AT CHEVRON OIL, INC.

Location: Chevron Oil, Inc.
Date: August 8; August 9, 1984
Time: 11:55 a.m.-12:55 p.m., Aug. 8;
9:28 a.m.-12:40 p.m., Aug. 9
Helicopter Model: Bell 206B Jetranger III

Temperature: 88 F, Aug. 8; 83 F, Aug. 9
Dew Point: 60, Aug. 8; 41, Aug. 9
Wind Speed: 3 - 8 knots from N (both days)

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient with helicopter test manuevers.	11:55-12:55 (August 8)	1 Hour	88[1]	86	80	72	61	50	49	46	68	Includes moderate GA operations, several in-service helicopter manuevers.
Ambient without helicopter test manuevers.	9:28-10:28 (August 9)	1 Hour	93[2]	91	88	77	65	52	49	46	74	Includes several in-service helicopter operations, light GA and jet activity at airport.
Ambient without helicopter test manuevers.	10:38-11:38 (August 9)	1 Hour	97[3]	86	85	71	59	53	50	48	72	Includes several in-service helicopter operations, light GA activity at airport.
Ambient without helicopter test manuevers.	11:40-12:40 (August 9)	1 Hour	92[4]	88	83	72	57	52	49	48	70	Includes several in-service helicopter operations, moderate GA operations.

All noise data were recorded with A-frequency weighting and slow response time averaging.
[1] = Lmax recorded from GA taxi 50' away.
[2] = Lmax recorded from Bell 206B flyover 20' away at 80' altitude.
[3] = Lmax recorded from 676 flyover 30' away at 10' altitude.
[4] = Lmax recorded from GA takeoff 300' away.

the sample periods. In addition to these fixed-wing aircraft operations, there were also several civilian and military helicopter operations near the station. The differing numbers of aircraft and helicopter operations occurring in the four sample periods makes it difficult to estimate the exact contribution of the helicopter test maneuvers to the normal ambient noise levels at this location.

Ambient Leq levels from the three sample periods without helicopter test maneuvers ranged from 70 dB(A) to 74 dB(A). By comparison, the ambient Leq level recorded during the sample period with the helicopter test maneuvers was only 68 dB(A). It should be noted, however, that there were no helicopter takeoff or landing maneuvers performed during this test.

While it is difficult to determine the amount of the contribution of the helicopter test maneuvers to the background ambient noise levels, it is evident from the data that the noise levels from the helicopter tests are well within the levels of ambient noise without the helicopter maneuvers. This could have been expected because of the close proximity of the helipad to the airport runway and the National Guard helicopter facility which has several operations a day.

Table 8.6 presents selected Lmax values recorded at Station 3 for noise not attributable to the helicopter test maneuvers (primarily from GA aircraft and in-service helicopter operations) recorded during the ambient noise sample periods, and the Lmax values recorded during the helicopter test maneuvers. Lmax values measured during GA aircraft operations at the airport ranged from 60 dB(A) from a GA aircraft taxiing approximately 400 feet away to two 92 dB(A) readings for a GA aircraft taxing approximately 50 feet away and a GA takeoff approximately 300 feet away. Lmax levels during regular

TABLE 8.8 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3
CHEVRON OIL, INC.

Location: Chevron Oil, Inc.
Date: Aug. 6, 1984; Aug. 8, 1984
Time: 11:55 a.m.-12:55 p.m., Aug. 6, 1984
8:28 a.m.-12:48 p.m., Aug. 8, 1984

Temperature: 86 F, Aug. 6; 83 F, Aug. 8
Dew Point: 60, Aug. 6; 41, Aug. 8
Wind Speed: 3 - 6 knots from N (both days)

Event	Lmax
Traffic:	
Truck braking 150' away.	78
Truck braking 200' away.	80
Truck engine start 300' away.	60
Truck passing 60' away.	81
Truck taxiing 400' away.	80
Aircraft:	
GA warm-up 50' away.	84
GA taxi 50' away.	80
GA taxi 85' away.	85
GA taxi 400' away.	60
GA taxi 50' away.	92
GA taxi 60' away.	75
GA taxi 50' away.	74
GA takeoff 3000' away.	65
GA takeoff 3000' away.	68
GA takeoff 3000' away.	65
GA takeoff 2500' away.	66
GA takeoff 2000' away.	73
GA takeoff 300' away.	92
GA Landing 2300' away.	63
Jet takeoff 3000' away.	76
Jet takeoff 3000' away.	78
Jet takeoff 3000' away.	64
Jet taxi 2000' away.	65
Jet approach 3000' away.	78
Helicopter Hovers:	
Medium size helicopter hover 800' away.	65
Medium size helicopter hover 400' away.	75
Same as above 500' away.	74
Medium size helicpter hover 450' away at 20' altitude.	84

Event	Lmax:
Helicopter Takeoffs:	
Military Bell 214 200' away.	77
S70 300' away.	86
Small size helicopter.	73
Small size helicopter 50' away at 50' altitude.	87
Medium size helicopter 600' away.	80
S76 500' away at 10' altitude.	90
Medium size helicopter 50' away at 20' altitude.	83
Military Bell 214 600' away.	70
Helicopter Approaches:	
Medium size helicopter landing 1500' away.	62
Medium size helicopter landing 500' away.	82
Small size helicopter landing 600' away.	77
Military Bell 214 200' away at 15' altitude.	87
Helicopter Flyovers:	
Bell 206B 60' away at 20' altitude.	93
Bell 206B 50' away at 30' altitude.	88
Small helicopter 50' overhead.	88
Medium helicopter 50' away at 50' altitude.	88
Bell 206B 50' away at 30' altitude.	90
S76 30' away at 10' altitude.	97

All noise data were recorded with A-frequency weighting and slow response time averaging.

(Table continued on next page)

Table 8.6 (continued)

Helicopter Idles:	Lmax
Military Bell 600' away.	70
Medium size helicopter Idle (West) 600' away.	63
Medium size helicopter Idle (North) 800' away.	62
Military Bell 214 Idle(North) 800' away.	65
S76 400' away.	71
Small helicopter 800' away.	66
Medium size helicopter 400' away.	63
S76 100% Takeoff(Idle) 400' away.	71
Bell 214 82% Ground Idle(North) 900' away.	72
Same helicopter at 100% Flight Idle(North) 900' away.	76
Helicopter Test Maneuvers:	
100% Takeoff Idle(North)	72
Hover(North)	78
Hover(East)	81
100% Takeoff Idle(South)	73
Hover(South)	76
Hover(West)	74
100% Takeoff Idle(West)	70
82% Idle(West)	83

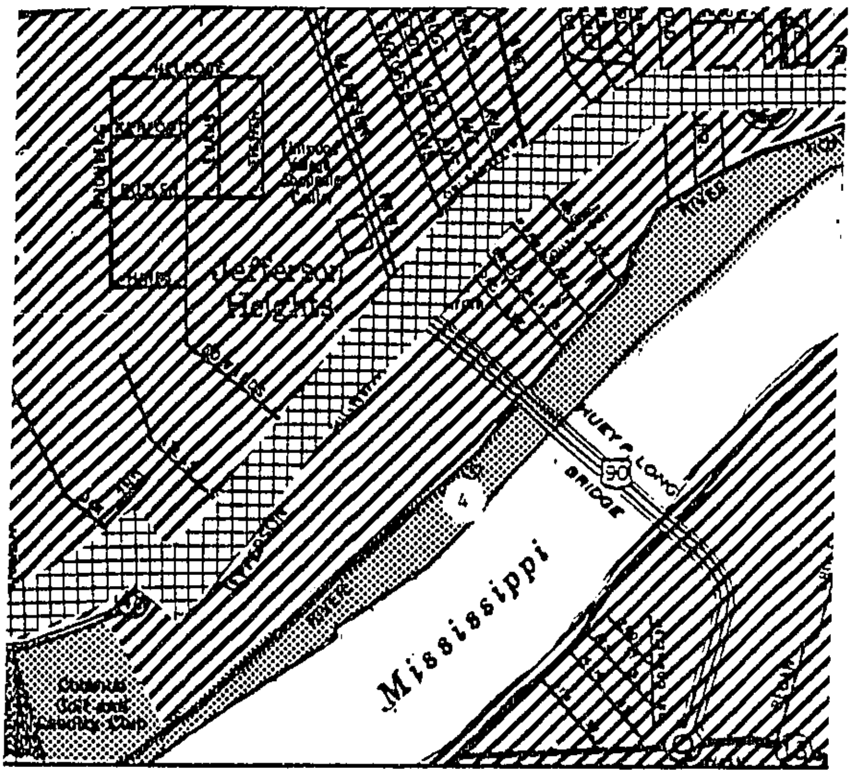
All noise data were recorded with A-frequency weighting and slow response time averaging.

in-service civilian and military helicopter operations ranged from 62 dB(A) during a helicopter landing approximately 1500 feet away to 97 dB(A) during a S76 helicopter landing when at an altitude of 10 feet and a lateral ground distance of approximately 30 feet from the microphone.

The Lmax values recorded during the standardized helicopter test maneuvers ranged from 63 dB(A) from the engine cooldown to 81 dB(A) form a hover facing east. The Lmax values recorded for the helicopter test maneuvers are well within the range of Lmax values recorded at the airport during regular GA and helicopter operations.

8.2.3 Petroleum Helicopters, Inc.

The Petroleum Helicopters, Inc. (PHI) helipad facility, (location 4 in Figure 8.1) consists of twelve helipads. It is located in Jefferson Parish, a community situated approximately five miles to the southwest of the New Orleans city limits. Land use in the vicinity of Petroleum Helicopters, Inc. is shown in Figure 8.11. The Mississippi River is located approximately one-fourth mile to the southeast of the helipads beyond a narrow strip of undeveloped land. To the northwest of the helipads a two-lane street, River Road, runs northeast to southeast. Jefferson Highway, a four-lane divided street, is located two blocks further to the north. Land use along Jefferson Highway consists of light manufacturing businesses with some commercial and retail establishments. Land use between Jefferson Highway and River Road to the North, East, and West is primarily detatched single family residential housing. A golf course is located approximately two miles to the southwest of the helipads between River Road and Jefferson Highway.



Helipad Location:
4. Petroleum Helicopter, Inc.

Legend:

N ↑

Single Family Residential

Commercial/Retail

Open Space/Parks

Waterway

Figure 8.11 Land Use in the Vicinity of Petroleum Helicopters, Inc. Helipads

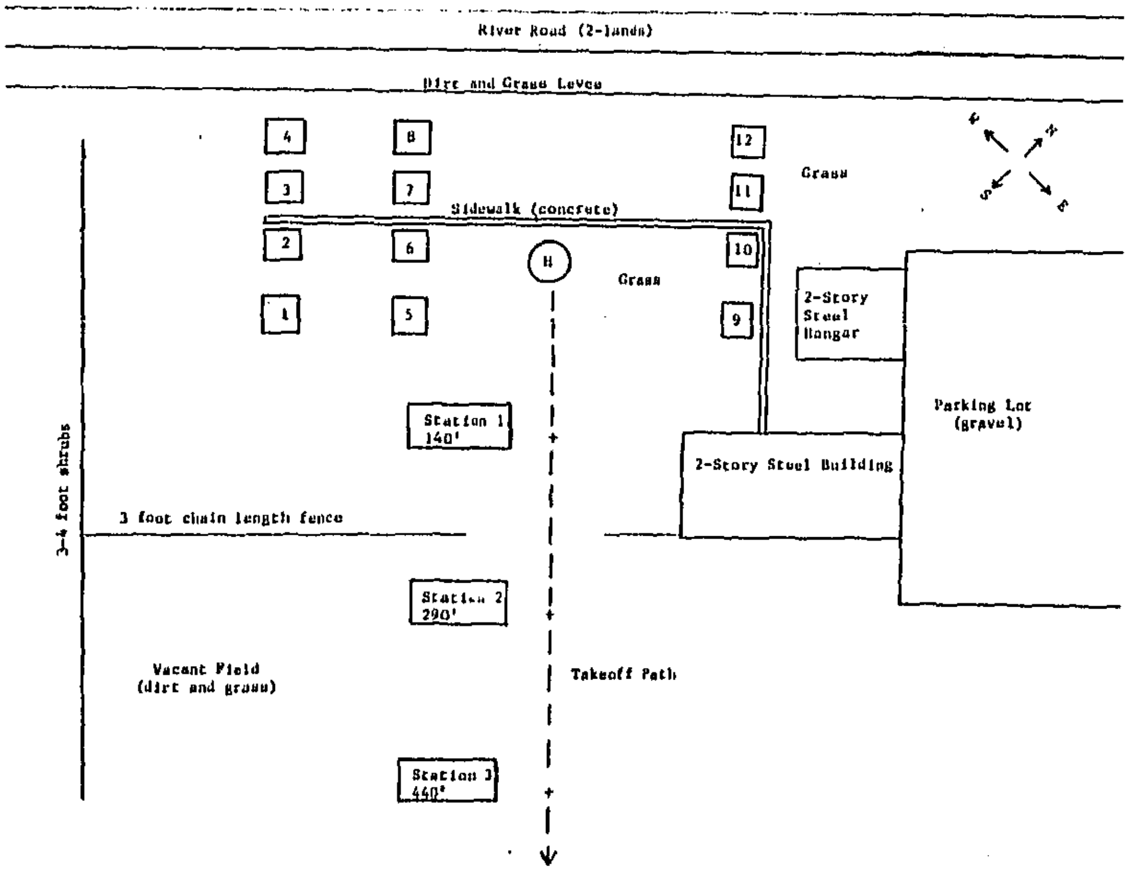


Figure 8.12 Site Schematic for Petroleum Helicopters, Inc. Test Site

Three noise monitoring stations were set up in a straight line 140 feet, 290 feet, and 440 feet south from the test helipad, respectively. The test helipad was located on a grassy area between two rows of helipads so as to enable the monitoring stations to be in a straight line from the test helipad. Figure 8.12 is a site schematic showing the noise measurement stations and the surrounding area as well as the flight path used for the takeoff maneuver. The three noise monitoring stations were set up on a grass surface in a vacant field to the southeast of the test helipad. A gravel parking lot for PHI is situated approximately 200 feet to the east of the cluster of helipads. River Road was approximately 700 feet to the north of Station 1. The Mississippi River was approximately 1000 feet to the south of Station 3.

Background ambient noise levels were relatively low in the vicinity of the helipads. Several short duration ambient noise samples taken with a B & K integrating sound level meter before the helicopter tests began showed Leq levels ranging between 54 dB(A) and 55 dB(A).

Using a Bell 206B Jetranger III helicopter, the Petroleum Helicopters, Inc. pilot performed eight maneuvers, listed below in the order in which they occurred:

1. Hover (South);
2. Hover (West);
3. 100% Flat Pitch, Idle
4. Hover (North);
5. 100% Flat Pitch, Idle, North;
6. Hover (East);
7. 100% Flat Pitch, Idle, East;
8. Takeoff, to South.

Table 8.7 shows the noise levels recorded during these maneuvers at the three measurement stations. On the hover facing south maneuver, when the tail rotor of the test helicopter was farthest away from the measurement array, Station 1 recorded a Lmax value of 80.3 dB(A), 5.5 dB(A) less than on the hover facing east (85.2 dB(A)), and 4.9 dB(A) less than on the hover facing west (85.2 dB(A)), with the helicopter perpendicular to the noise measurement array. The takeoff maneuver was executed directly over the noise measurement array using a relatively shallow ascent angle. Charts of SPL for the test maneuvers recorded at Stations 1, 2, and 3 are shown in Figures 8.13, 8.14, and 8.15, respectively.

Table 8.8 presents ambient noise level data obtained at Station 3 for three consecutive one-hour sample periods. The first sample period includes the helicopter test maneuvers, the other two do not. The Leq levels recorded for all three samples vary within a range of only 3 dB(A). This is because all three ambient noise sample periods included several in-service helicopter operations at the PHI helipads However, several short duration noise samples were taken with the B & K meter at Station 3 with no helicopter activity occurring. These samples yielded Leq levels ranging from 54 dB(A) to 55 dB(A). This would indicate that the regular in-service helicopter activity occurring during the one-hour sample periods resulted in Leq levels 11 dB(A) to 14 dB(A) higher than the Leq levels in the samples with no helicopter activity.

Table 8.9 shows selected Lmax values recorded at Station 3 during the three ambient noise sample periods for noise not attributable to the helicopter test maneuvers, and the Lmax values recorded during the test maneuvers. The data include Lmax values from non-helicopter noise sources as well as for the helicopter tests and for regular in service helicopter non-test

TABLE 8.7 NOISE DATA FOR STANDARDIZED HELICOPTER MANEUVERS AT PETROLEUM HELICOPTERS, INC.

Location: Petroleum Helicopters, Inc.
Date: August 7, 1984
Time: 8:45 a.m.
Helicopter Model: Bell 206B Jetranger III

Temperature: 73 F
Relative Humidity: 87
Wind Speed: 0 - 1 knots from S

Station	Dist. From Pad (ft.)	Hover(South) Time (sec.)	Leq	SEL	Lmax	Hover (West) Time (sec.)	Leq	SEL	Lmax	100% Idle (West) Time (sec.)	Leq	SEL	Lmax	Hover (North) Time (sec.)	Leq	SEL	Lmax
1	140	23	79.2	92.7	80.3	22	84.3	97.7	85.2	20	81.7	94.7	82.9	22	83.0	96.3	84.7
2	200	23	74.1	88.0	75.9	22	75.2	88.6	76.7	21	74.9	87.9	75.9	22	74.6	88.0	76.4
3	440				70				70				69				69

Station	Dist. From Pad (ft.)	100% Idle(North) Time (sec.)	Leq	SEL	Lmax	Hover (East) Time (sec.)	Leq	SEL	Lmax	100% Idle (East) Time (sec.)	Leq	SEL	Lmax	Takeoff[1] Time (sec.)	Leq	SEL	Lmax
1	140	26	81.5	95.6	80.9	28	84.1	98.5	86.8	28	82.6	97.0	83.5	15	90.7	102.4	98.4
2	200	26	75.3	89.4	76.5	28	78.3	92.7	79.7	28	75.8	90.2	76.9	15	85.7	97.4	91.3
3	440				71				73				69				90

All noise data recorded with A-frequency weighting and slow response time averaging.
[1]=Helicopter estimated at 60' altitude as it passed directly over Station 2 (visual judgement).

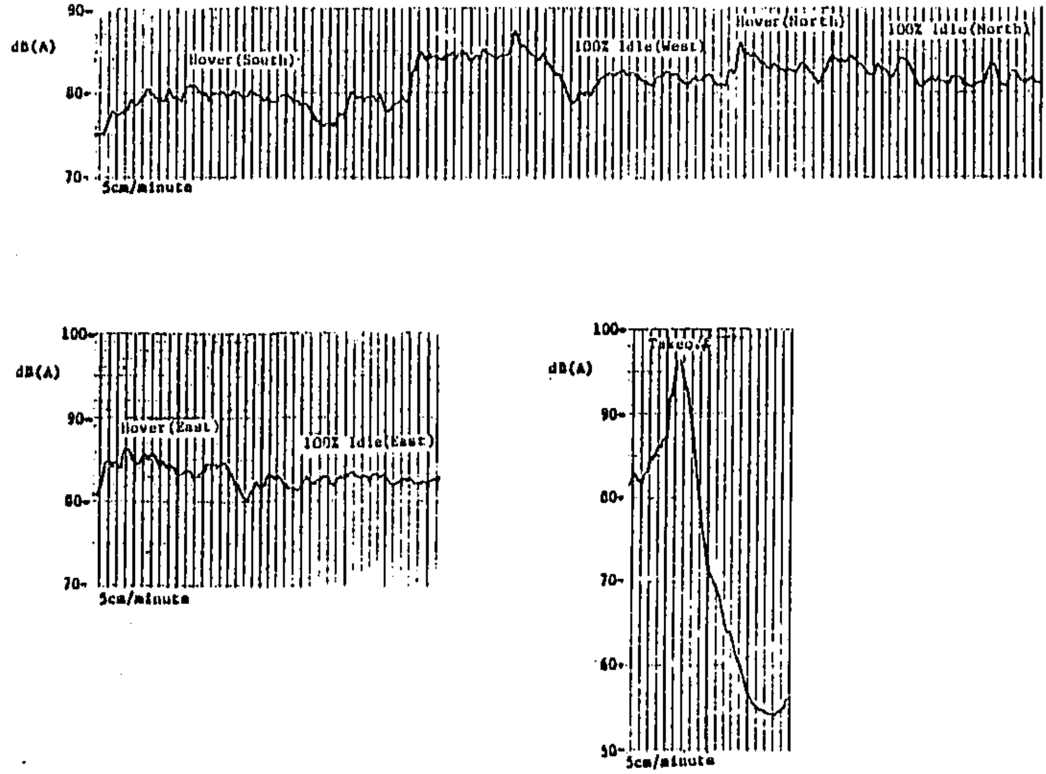


Figure 8.13 Sound Pressure Levels for Petroleum Helicopters Inc. Test - Station 1

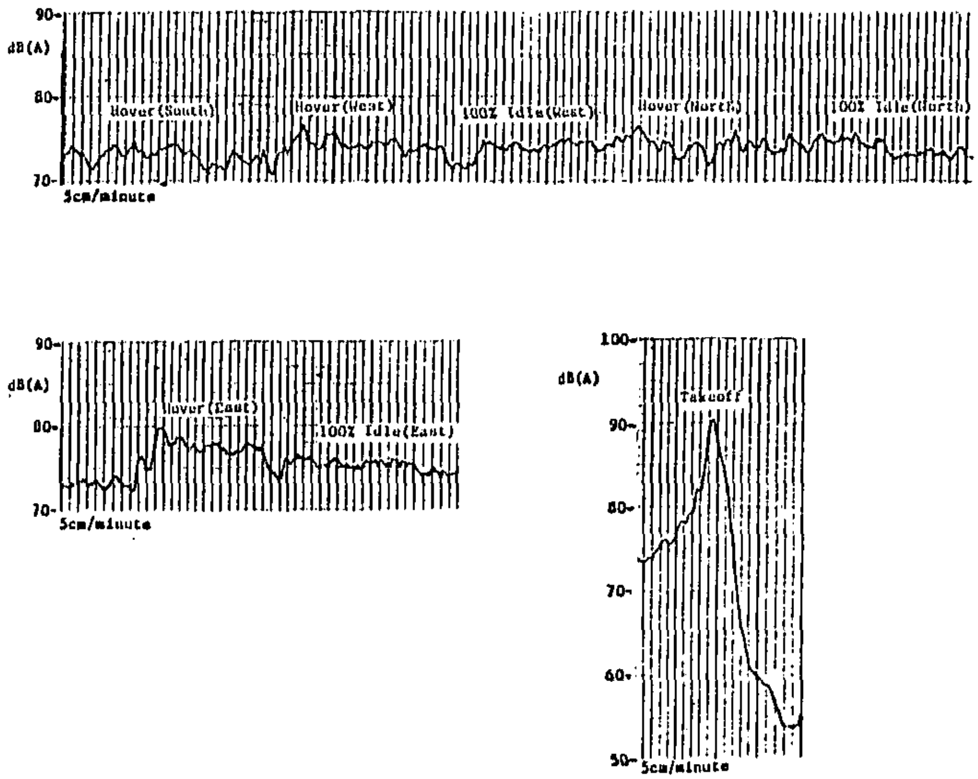


Figure 8.14 Sound Pressure Levels for Petroleum Helicopters Inc. Test - Station 2

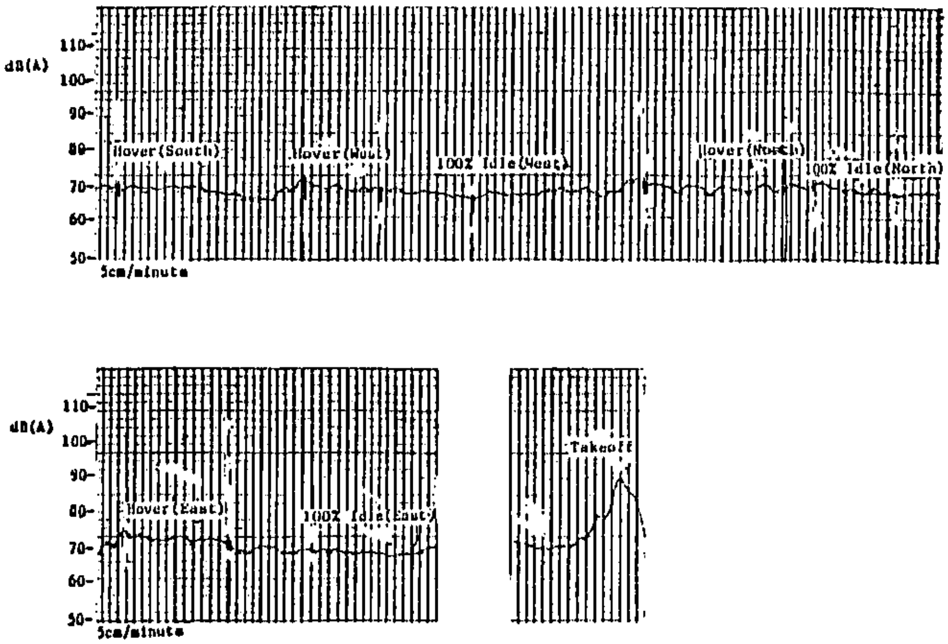


Figure 8.15 Sound Pressure Levels for Petroleum Helicopters Inc. Test - Station 3

TABLE 6.8 AMBIENT NOISE LEVELS AT PETROLEUM HEICOPTERS, INC.

Location: Petroleum Helicopters, Inc.
Date: August 7, 1984
Time: 6:48 a.m.-9:48 a.m.
Helicopter Model: Bell 206B Jetranger III

Temperature: 73 F
Relative Humidity: 87%
Wind Speed: 0 - 1 knots from S

Ambient Description	Sample Time	Measurement Duration	Lmax	L0.1	L1.0	L10	L50	L90	L99	Lmin	Leq	Remarks
Ambient with helicopter test maneuvers.	6:48-7:48	1 Hour	84[1]	84	77	71	60	55	54	54	67	Includes 1 helo takeoff and 4 helos maneuvering around pads in addition to test maneuvers.
Ambient without helicopter test maneuvers.	7:48-8:48	1 Hour	90[2]	87	76	66	57	55	54	53	68	Includes 6 helo takeoffs, 1 landing, 5 flyovers, and 4 helos maneuvering around pads.
Ambient without helicopter test maneuvers.	8:48-9:48	1 Hour	91[3]	89	80	68	58	54	53	52	68	Includes 4 helo takeoffs, 1 landing, 2 flyovers, and 4 helos maneuvering around pads.

All noise data were recorded with A-frequency weighting and slow response time averaging.
[1] = Lmax recorded from in-service Bell 206 approach 150' overhead.
[2] = Lmax recorded from test helicopter takeoff.
[3] = Lmax from in-service Bell 206B approach 50' overhead.

TABLE 6.9 SELECTED COMPARISON OF MAXIMUM SOUND LEVELS AS RECORDED AT STATION 3
PETROLEUM HELICOPTERS, INC.

Location: Petroleum Helicopters, Inc.
Date: August 7, 1984
Time: 8:40 a.m.-9:48 a.m.

Temperature: 73 F
Relative Humidity: 87%
Wind Speed: 0 - 3 knots from S

Event	Lmax
Helicopter Takeoffs:	
Bell 206B west, perpendicular to array.	69
Bell 206B 300' overhead.	76
Bell 206B 500' overhead.	71
Bell 206B 500' overhead.	73
Bell 206B 75' overhead.	87
Same as above.	80
Same as above.	80
Same as above.	85
Same as above.	80
Bell 206B west perpendicular to measurement array.	71
Helicopter Approaches:	
Bell 206B 150' overhead.	84
Bell 206B 50' overhead.	81
Helicopter Flyovers:	
Bell 206B at 500' altitude.	79
Bell 206B at 300' altitude.	77
Bell 206B at 800-1000' altitude.	64
Same as above.	60
Same as above.	69
Same as above.	67
Same as above.	65

Miscellaneous:	Lmax
Construction hammering 1000' away.	62
Siren 1/4 to 1/2 mile away.	66
Barges 1000' away on river.	60
Truck 500' away.	60
Loud speaker 250' away.	65
Construction hammering 1000' away.	61
Tractor start-up 500' away.	64
Construction hammering 1000' away.	64
Jet flyover 4000'-6000' altitude.	74
Jet flyover 4000'-6000' altitude.	70
Jet flyover 4000'-6000' altitude.	72
Tractor 250' away.	61
No intrusive noise sources	59
Helicopter Test Maneuvers	
Hover(South)	70
Hover(West)	70
100% Idle(West)	69
Hover(North)	69
100% Idle(North)	71
Hover(East)	73
100% Idle(East)	69
Takeoff	80

All noise data were recorded with A-frequency weighting and slow response time averaging.

sources. Most of the intrusive noise occurrences were from in-service helicopter operations. These operations produced Lmax values that ranged from 64 dB(A) for a Bell 206B helicopter flyover at between 800 and 1000 feet altitude to 91 dB(A) for a Bell 206B Jetranger III approach 50 feet directly overhead. Most of the non-helicopter and non-aircraft noise occurrences measured during the sample periods produced Lmax values on the order of 60 dB(A) to 66 dB(A), generally lower noise levels than for the helicopter maneuvers. The highest Lmax level recorded for a non-helicopter noise event was 78 dB(A) for a jet flyover at between 4000 to 5000 feet altitude.

8.3 ACTUAL IN-SERVICE HELICOPTER OPERATIONS

Noise levels from several actual in-service helicopter operations were measured at six locations in the New Orleans area. Three of the locations were at the helipads used in the standardized maneuver tests. At these three locations, monitoring equipment was left in place after the test maneuvers were completed to obtain additional noise level data from actual in-service helicopter operations in the vicinity of these helipads. A fourth monitoring location was situated on a grass surface adjacent to the south runway of Lakefront Airport in front of the Louisiana National Guard helicopter facility. The other two monitoring locations were located approximately one-half mile to the south of Lakefront Airport in a predominantly residential area. Figure 8.16 shows the locations of the monitoring sites. Table 8.10 shows the noise data obtained from all of the in-service monitoring sites.

Locations 1 and 2 in Figure 8.16 were at the Pumpkin Helicopters and Chevron Oil test sites. Location 3 in Figure 8.16 was in front of the Louisiana National Guard Helicopter facility. All

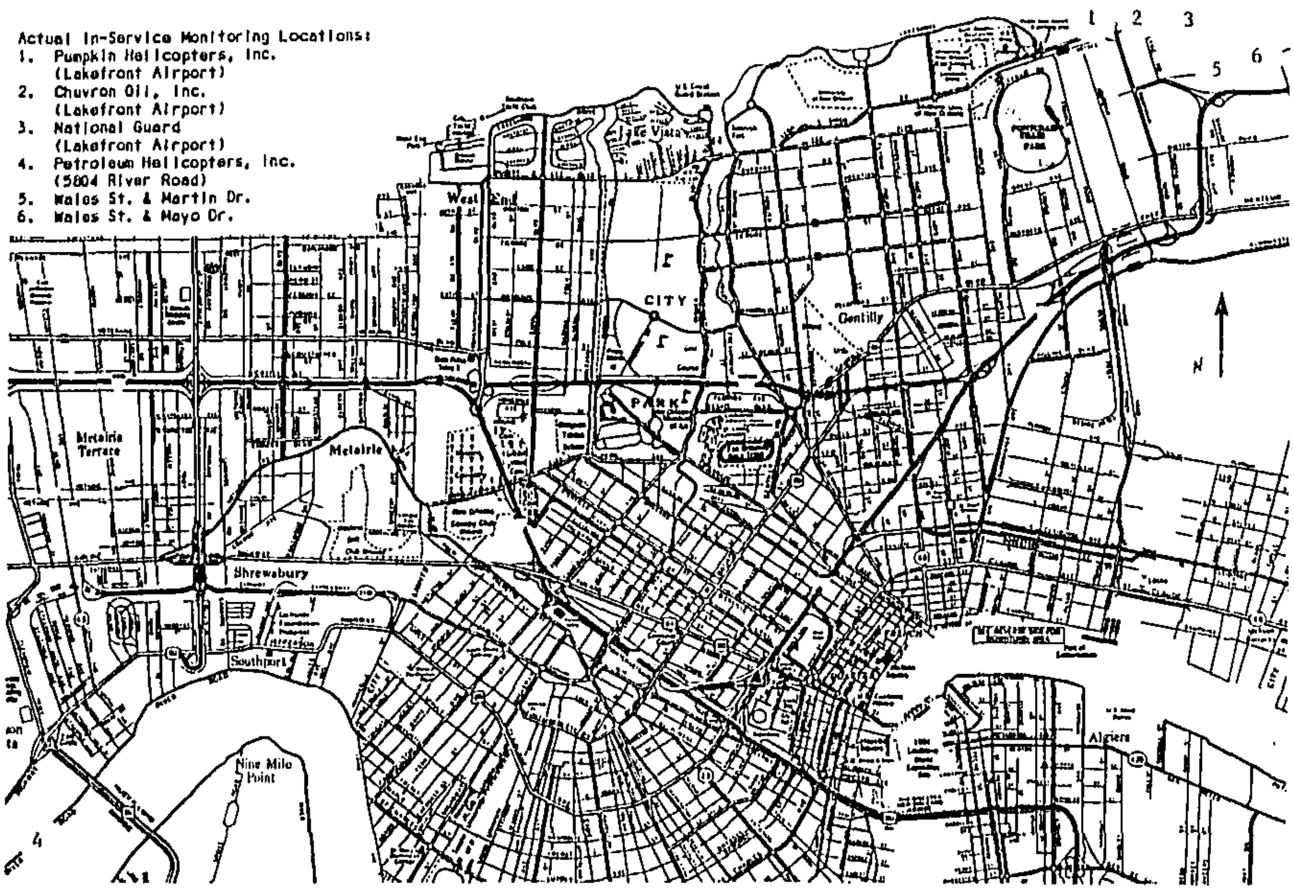


Figure 8.16 Locations of Actual In-Service Operations Monitoring Stations

TABLE 8.10 NOISE DATA FOR ACTUAL IN-SERVICE HELICOPTER OPERATIONS

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Bell 206L takeoff 30' from away.	1 (Station 1)	70	17	87.3	98.6	91.4
Bell 206L 62% Idle (West) 345' away.	1 (Station 1)	N/A	28	71.0	85.4	72.2
Same as above 509' away.	1 (Station 2)	N/A	28	68.2	82.6	69.3
Same as above 666' away.	1 (Station 3)	N/A	[1]	[1]	[1]	67
Bell 206B approach 30' away.	1 (Station 1)	40	24	84.1	97.9	91.3
Same as above 104' away.	1 (Station 2)	40	25	77.8	91.8	84.4
Same as above 350' away.	1 (Station 3)	40	[1]	[1]	[1]	83
Bell 206B Hover (West) 25' away.	1 (Station 1)	25	12	76.5	86.9	79.0
Same as above 180' away.	1 (Station 2)	25	14	69.7	81.1	74.0
Same as above 346' away.	1 (Station 3)	25	[1]	[1]	[1]	69
Bell 206L takeoff 40' parallel to array, turned west between Station 2 & 3.	1 (Station 1)	40	18	86.4	98.4	92.4
Same as above.	1 (Station 2)	40	16	84.9	96.9	91.6
Same as above.	1 (Station 3)	40	[1]	[1]	[1]	91

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figure 8.10 for station locations.
[1] Noise levels measured with the CNA which is not capable of recording measurement duration, Leq, and SEL for single-event.

(continued on next page)

TABLE 8.10 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Bell 206B 82% Idle 200' away.	1 (Station 1)	N/A	38	73.2	88.7	74.9
Same as above 350' away.	1 (Station 2)	N/A	38	68.2	83.7	70.1
Same as above 500' away.	1 (Station 3)	N/A	[1]	[1]	[1]	68
Bell 206B takeoff 50' away parallel to array.	1 (Station 1)	40	15	83.5	95.2	80.1
Same as above.	1 (Station 2)	40	17	82.5	94.8	80.5
Same as above.	1 (Station 3)	40	[1]	[1]	[1]	88
Bell 206B flyby 100' away.	1 (Station 1)	500	21	56.7	69.8	58.7
Same as above.	1 (Station 2)	500	23	53.5	67.2	58.3
Medium size helo landing 2000' away.	1 (Station 3)	N/A	[1]	[1]	[1]	63
Bell 206B warm-up 300' away.	2 (Station 2)	N/A	18	67.0	79.6	68.8
Bell 214 Idle 600' away.	2 (Station 3)	N/A	[1]	[1]	[1]	70
Bell 214 Idle (North) 800' away.	2 (Station 3)	N/A	[1]	[1]	[1]	65
Small helicopter landing 1000' away.	2 (Station 3)	N/A	[1]	[1]	[1]	66
Medium helicopter hover 800' away.	2 (Station 3)	30	[1]	[1]	[1]	65

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figure 8.18 for station locations.
[1] Noise levels measured with CNA which is not capable of recording measurement duration, Leq, and SEL for single-event.

(continued next page)

TABLE 8.10 (continued)

Event Description	Location	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Medium size helo Idle(North) 800' away.	2 (Station 3)	N/A	[1]	[1]	[1]	62
Medium size helo hover(west) 400' away.	2 (Station 3)	30	[1]	[1]	[1]	75
Same as above 500' away.	2 (Station 3)	30	[1]	[1]	[1]	74
Bell 206B Flyover 60' away.	2 (Station 3)	20	[1]	[1]	[1]	83
Bell 206B Flyover 50' away.	2 (Station 3)	30	[1]	[1]	[1]	88
S76 Idle 400' away.	2 (Station 3)	NA	[1]	[1]	[1]	71
S76 taxi 400' away.	2 (Station 3)	NA	[1]	[1]	[1]	87
S76 takeoff 60' away.	2 (Station 3)	NA	[1]	[1]	[1]	87
Medium helo landing 1500' away.	2 (Station 3)	NA	[1]	[1]	[1]	62
Same as above 500' away.	2 (Station 3)	NA	[1]	[1]	[1]	82
Bell 214 takeoff 200' away.	2 (Station 3)	NA	[1]	[1]	[1]	77
S76 takeoff 300' away.	2 (Station 3)	NA	[1]	[1]	[1]	86
Small helo flyby directly overhead.	2 (Station 3)	50	[1]	[1]	[1]	80
Small helo takeoff 600' away.	2 (Station 3)	NA	[1]	[1]	[1]	73

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figure 8.16 for station locations.
[1]= Noise Levels measured with CNA which is not capable of recording duration, Leq, or SEL for single-event.

(continued on next page)

TABLE 8.10 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Small helo landing 600' away.	2 (Station 3)	NA	[1]	[1]	[1]	77
Small helo 82% Idle 600' away.	2 (Station 3)	NA	[1]	[1]	[1]	68
Small helo takeoff 50' away.	2 (Station 3)	50	[1]	[1]	[1]	87
Bell 214 landing 600' away.	2 (Station 3)	NA	[1]	[1]	[1]	74
Medium size helo flyover directly overhead.	2 (Station 3)	50	[1]	[1]	[1]	88
Medium size helo takeoff 600' to west.	2 (Station 3)	NA	[1]	[1]	[1]	80
S76 takeoff 500' away.	2 (Station 3)	10	[1]	[1]	[1]	90
Bell 206B flyover 50' away.	2 (Station 3)	30	[1]	[1]	[1]	80
S76 landing 30' away.	2 (Station 3)	10	[1]	[1]	[1]	87
Medium size helo takeoff 50' away.	2 (Station 3)	20	[1]	[1]	[1]	83
Bell 214 approach 200' away.	2 (Station 3)	15	[1]	[1]	[1]	87
Medium size helo idle 400' away.	2 (Station 3)	NA	[1]	[1]	[1]	83
Bell 214 hover taxi 500' away.	2 (Station 3)	NA	[1]	[1]	[1]	82
Bell 214 takeoff to west 600' away.	2 (Station 3)	NA	[1]	[1]	[1]	79

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figure 8.10 for station locations.
[1]= Noise Levels measured with CNA which is not capable of recording duration, Leq, or SEL for single-event.

(continued on next page)

Table 8.10(cont)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Bell 206L takeoff 150' away.	3	30	[1]	[1]	[1]	81
Medium size helo approach 200' away.	3	100	[1]	[1]	[1]	80
Medium size helo flyby 300' away.	3	700	[1]	[1]	[1]	67
Medium size helo 82% idle 600' away.	3	NA	[1]	[1]	[1]	57
Same as above 100% idle.	3	NA	[1]	[1]	[1]	64
Medium size helo idle 300' away.	3	NA	[1]	[1]	[1]	73
Same as above 450' away.	3	NA	[1]	[1]	[1]	61
Same as above 300' away.	3	NA	[1]	[1]	[1]	57
Military Bell 214 idle 500' away.	3	NA	[1]	[1]	[1]	70
Medium size helo hovering 300' away.	3	NA	[1]	[1]	[1]	63
Same as above.	3	NA	[1]	[1]	[1]	81
Medium size helo takeoff overhead.	3	NA	[1]	[1]	[1]	80
Bell 206B takeoff 150' away.	3	NA	[1]	[1]	[1]	84

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figure 8.18 for station locations.
[1] Noise levels measured with CNA which is not capable
of recording measurement duration, Leq, and SEL for single-event.

(continued on next page)

TABLE 8.10 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Medium size helo flyover overhead.	3	NA	[1]	[1]	[1]	78
Medium size helo flyover 150' away.	3	NA	[1]	[1]	[1]	82
Bell 206B approach west of station.	4 (Station 3)	150	[1]	[1]	[1]	84
Same as above 30' west of station.	4 (Station 2)	40	43	82.4	98.7	90.8
Same as above directly over station.	4 (Station 1)	40	44	80.7	100.1	88.3
bell 206B 62% idle 121' away.	4 (Station 1)	NA	14	75.3	86.7	77.0
Bell 206B takeoff (south) 80' west of array.	4 (Station 1)	200	15	75.1	80.8	78.1
Same as above.	4 (Station 2)	250	15	74.5	86.2	77.8
Same as above.	4 (Station 3)	300	[1]	[1]	[1]	76
Bell 206B 62% idle 250' away.	4 (Station 1)	NA	28	77.8	92.1	70.0
Same as above 400' away.	4 (Station 2)	NA	28	68.3	82.4	80.1
Same as above 580' away.	4 (Station 3)	NA	[1]	[1]	[1]	59
Bell 206B 100% idle 287' away.	4 (Station 1)	NA	12	83.0	94.7	85.7
Same as above 400' away.	4 (Station 2)	NA	12	75.8	86.5	77.2
Same as above	4					

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figure 8.16 for station locations.
[1] Noise levels measured with CNA which is not capable of recording measurement duration, Leq, and SEL for single-event.

(continued on next page)

TABLE 8.10 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
347' away.	(Station 3)	NA	[1]	[1]	[1]	87
Bell 206B takeoff (south) 800' away.	4 (Station 1)	200	28	71.1	85.5	73.7
Same as above.	4 (Station 2)	250	29	88.2	83.8	72.3
Same as above.	4 (Station 3)	250	[1]	[1]	[1]	71
Bell 206B 100% idle 207' away.	4 (Station 1)	NA	23	80.4	94	81.3
Same as above 348' away.	4 (Station 2)	NA	23	72.8	86.4	73.7
Same as above 484' away.	4 (Station 3)	NA	[1]	[1]	[1]	65
Bell 206B takeoff (south) 50' west.	4 (Station 1)	250	46	73.4	90	83.6
Same as above.	4 (Station 2)	300	46	70.0	86.8	78.4
Same as above.	4 (Station 3)	500	[1]	[1]	[1]	73
Bell 206B flyover 800' west.	4 (Station 1)	500	27	60.9	75.2	63.9
Same as above.	4 (Station 2)	500	27	60.3	74.5	63.0
Same as above.	4 (Station 3)	500	[1]	[1]	[1]	64
Bell 206B 82% idle 223' away.	4 (Station 1)	NA	26	65.5	79.7	67.8
Same as above 302' away.	4 (Station 2)	NA	26	65.5	79.7	67.0

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figure 8.16 for station locations.
[1] Noise levels measured with CNA which is not capable of recording measurement duration, Leq, and SEL for single-event.

(continued on next page)

TABLE 8.10 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax	
Same as above 507' away.	4 (Station 3)	NA	[1]	[1]	[1]	83	
Same Bell 206 at 100% idle 223' away.	4 (Station 1)	NA	21	79.3	92.4	80.6	
Same as above 382' away.	4 (Station 2)	NA	21	72.4	85.6	73.8	
Bell 206B 62% idle 260' away.	4 (Station 1)	NA	30	70.4	85.9	72.3	
Same as above 410' away.	4 (Station 2)	NA	37	61.4	77.1	64.0	
Same Bell 206B at 100% idle 260' away.	4 (Station 1)	NA	19	75.0	87.9	77.4	
Same as above 410' away.	4 (Station 2)	NA	20	67.4	80.4	68.1	
Same as above 580' away.	4 (Station 3)	NA	[1]	[1]	[1]	64	
Same Bell 206 takeoff 50' east.	4 (Station 1)	75	20	82.7	95.7	88.8	
Same as above.	4 (Station 3)	75	20	81.1	94.0	87.1	87
Same as above.	4 (Station 3)	75	[1]	[1]	[1]	87	
Bell 206 62% idle 177' away.	4 (Station 1)	NA	18	73.8	86.2	74.6	
Same as above 310' away.	4 (Station 2)	NA	18	67.2	79.7	69.3	
Same as above 463' away.	4 (Station 2)	NA	[1]	[1]	[1]	88	

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figure 8.16 for station locations.
[1] Noise levels measured with CNA which is not capable of recording measurement duration, Leq, and SEL for single-event.

(continued on next page)

Table 8.10 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Same Bell 206B at 100% idle 177' away.	4 (Station 1)	NA	18	80.8	93.3	82.5
Same as above 310' away.	4 (Station 2)	NA	18	77.2	89.7	78.6
Same as above 463' away.	4 (Station 3)	NA	[1]	[1]	[1]	72
Bell 206B 62% idle 207' away.	4 (Station 1)	NA	45	71.1	87.6	72.3
Same as above 348' away.	4 (Station 2)	NA	45	63.2	79.7	64.3
Bell 206B flyover 800' west.	4 (Station 1)	500	19	65.7	78.4	68.2
Same as above.	4 (Station 2)	500	20	65.4	78.3	68.5
Same as above.	4 (Station 3)	500	[1]	[1]	[1]	69
Bell 206B takeoff (south) overhead.	4 (Station 1)	40	18	88.6	100.6	90.0
Same as above 50' west.	4 (Station 2)	50	18	83.4	95.4	90.0
Same as above 75' west.	4 (Station 3)	75	[1]	[1]	[1]	88
Bell 206B 62% idle 145' away.	4 (Station 1)	NA	27	76.7	91.0	77.7
Same as above 290' away.	4 (Station 2)	NA	28	68.8	83.2	70.8
Same as above 444' away.	4 (Station 3)	NA	[1]	[1]	[1]	62
Same Bell 206 at 100% idle 147' away.	4 (Station 1)	NA	19	83.0	95.7	83.0

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figure 8.16 for station locations.
[1] Noise levels measured with CNA which is not capable of recording measurement duration, Leq, and SEL for single-event.

(continued on next page)

TABLE 8.10 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Same as above 200' away.	4 (Station 2)	NA	20	74.0	87.0	75.9
Same as above 444' away.	4 (Station 3)	NA	[1]	[1]	[1]	68
Same Bell 206 takeoff(south) 50' west.	4 (Station 1)	30	16	85.0	97.0	91.5
Same as above.	4 (Station 2)	75	18	82.1	94.1	87.3
Same as above.	4 (Station 3)	100	[1]	[1]	[1]	86
Bell 206 flyover north to south 800' away.	4 (Station 1)	500	23	65.6	79.2	69.3
Same as above.	4 (Station 2)	500	18	66.1	78.6	68.5
Same as above.	4 (Station 3)	500	[1]	[1]	[1]	69
Bell 206B flyover south to north 800' east.	4 (Station 1)	500	19	65.2	77.0	68.1
Same as above.	4 (Station 2)	500	18	63.9	76.4	66.9
Same as above.	4 (Station 3)	500	[1]	[1]	[1]	67
Bell 206B 100% idle 267' away.	4 (Station 1)	NA	20	80.1	93.1	81.8
Same as above 400' away.	4 (Station 2)	NA	21	73.4	86.5	75.1

All noise data recorded with A-frequency weighting and slow response time averaging.
* See Figure 8.10 for station locations.
[1] Noise levels measured with CNA which is not capable
of recording measurement duration, Leq, and SEL for single-event.

(continued on next page)

TABLE 8.10 (continued)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Same as above 547'' away.	4 (Station 3)	NA	[1]	[1]	[1]	88
Same Bell 206B takeoff (south) overhead.	4 (Station 1)	40	22	83.8	97.2	91.8
Same as above.	4 (Station 2)	50	20	78.7	93.8	87.2
Same as above.	4 (Station 3)	75	[1]	[1]	[1]	85
Bell 200 approach south to north overhead.	4 (Station 3)	50	[1]	[1]	[1]	91
Same as above.	4 (Station 2)	50	37	84.3	100.2	91.3
Same as above.	4 (Station 1)	50	38	86.5	102.2	91.8
Bell 206B takeoff (south) overhead.	4 (Station 3)	75	[1]	[1]	[1]	88
Bell 206B flyover directly overhead flying north to south.	5	500	78	61.1	80.0	68.5
Bell 206B flyover 1500' away.	5	500	22	60.8	74.2	63.8
Bell 214 flyover east to west 1200' away.	5	300	84	61.2	80.3	68.1
Bell 206L 100' north of station.	5	200	44	70.5	86.9	78.7
Large helicopter flyover 500' away east to west.	5	300	27	63.3	77.5	87.4

All noise data recorded with A-frequency weighting and slow response time averaging.

* See Figure 8.18 for station locations.

[1] Noise levels measured with CNA which is not capable of recording measurement duration, Leq, and SEL for single-event.

(Table continued on next page)

Table 8.10(cont.)

Event Description	Location*	Estimated Altitude (in feet)	Measurement Duration (seconds)	Leq	SEL	Lmax
Large helicopter flyover 500' away east to west.	5	300	41	66.1	82.2	71.5
Bell 206B flyover 400' away east to west.	5	300	40	67.1	83.0	72.4
Bell 206B flyover to south 500' away.	5	400	52	60.8	77.9	65.5
Large helicopter flyover 600' away.	5	300	38	66.8	82.7	73.0
Bell 206B flyover 1000' west of station heading south.	6	300	44	57.8	74.1	62.8
Bell 206B flyover 1200' north of station flying west to east.	6	500	19	62.3	75.1	65.1
Bell 214 flying east to west 1200' away.	6	300	68	63.4	81.6	70.2
Bell 206L 100' south of station flying east to west.	6	200	23	76.7	90.3	81.5
Large helicopter flyover 1000' away.	6	300	25	63.7	77.6	68.0
Large helicopter directly overhead.	6	300	21	76.3	89.5	82.0
Bell 206B flyover 300' away.	6	300	26	67.3	81.4	71.4
Bell 206B flyover 600' away.	6	300	21	61.2	74.3	63.8
Large helicopter directly overhead.	6	250	21	73.2	86.4	78.0

All noise data were recorded with A-frequency weighting and slow response time averaging.
* See Figure 8.18 for station locations.
[1] Noise levels measured with the CNA which is not capable
of recording measurement duration, Leq, and SEL for single events.

three of these sites were on the southern perimeter of Lakefront Airport where most of the in-service helicopter operations took place. The Lmax values recorded from in-service helicopter operations at these three locations ranged from 56.3 dB(A) for a Bell 206B Jetranger III flyby at a lateral ground distance of 100 feet and an altitude of 500 feet to 97 dB(A) for a S76 helicopter landing at a lateral ground distance of 30 feet and an altitude of 10 feet.

Location 4 was at the Petroleum Helicopters, Inc. test site in Jefferson Parish, five miles to the southwest of the New Orleans city limits. Lmax values recorded at this location for in-service helicopter maneuvers ranged from 59 dB(A) for a Bell 206 B Jetranger III idling 550 feet away to 99.3 dB(A) for a Bell 206B Jetranger III approach directly overhead at 40 feet altitude.

Locations 5 and 6 are of particular interest because of their location in the residential area where most of the helicopter noise complaints in New Orleans originate. The noise monitoring station at Location 5 was positioned in a grass field in a small park near the corner of Wales Street and Martin Drive. Automobile traffic on both of these streets was very light. Location 6 was in a tall grass field at the corner of Wales Street and Mayo Road, six blocks to the east of Location 5. Street traffic around this location was also very light. Several short duration ambient noise samples were taken at both locations with the B & K ISLM meters, when no helicopter overflights were present, showed the area was very quiet with Leq levels generally from the high 40 dB(A) to low 50 dB(A) range.

The helicopter flyovers monitored were operations to and from Lakefront Airport. Most of the helicopters monitored departing from Lakefront Airport first flew for a short distance east along the railroad tracks that runs along the southern perimeter of the airport, and then turned southeast passing between Locations 5 and 6 at an altitude of between 250 to 300 feet. During the hours when the monitoring stations were set up (10:00 a.m. to 12:30 p.m.), Locations 5 and 6 monitored the same nine helicopter flyovers at varying distances from each station. The highest Lmax value recorded at Location 5 was for a Bell 206L flyover at a lateral ground distance of 100 feet and an altitude of 200 feet that registered 76.7 dB(A). The highest Lmax value recorded at Location 6 was from a large helicopter which passed directly overhead at 300 feet altitude that registered 82.8 dB(A). By comparison, the highest Lmax value recorded from a non helicopter noise source at Location 5 and 6 was 77 dB(A) from a small motorcycle accelerating 100 feet away on Wales Street and 84 dB(A) from a mini bike six feet away on Mayo Drive, respectively.

APPENDIX A

DEPARTMENT OF PUBLIC WORKS
333 WEST OCEAN BOULEVARD • LONG BEACH, CA 90802 • (213) 590-6322

September 2, 1982

NOTICE

TO All Helicopter Operators at Long Beach Airport

FROM Steve Glass, Airport Noise Abatement Officer

SUBJECT Helicopter Operations Noise Abatement Procedures

Due to the recent increase in helicopter related noise complaints in clearly defined noise impacted areas, helicopter operators, airport operations and management personnel, and the Air Traffic Control Tower Chief have held a series of meetings to discuss solutions to the problem. As a result of those meetings, a set of procedures has been identified which should ease the noise burden for citizens near helicopter operating areas:

1. Local traffic should remain west of the mid-point of Skylinks Golf Course and east of Cherry Ave. when west Traffic is in use, and north of Spring St. and south of Carson St. when south traffic is being used.

2. Pilots should radio the Tower at the boundary of the Airport Traffic Area at enroute altitude and request to remain at altitude until beginning the final approach to the Airport.

3. Traffic should remain at altitude on approach until decent is necessary due to traffic and/or aircraft requirements. Likewise, departing traffic should request ATC to approve immediate climb to en route altitude.

4. Helicopters arriving and departing from the east should use the north Downey - Artesia Freeway corridor rather than use the east Wardlow corridor.

5. Voluntary Noise Abatement Procedure: Non-local operations shall arrive/depart via climb/decent to/from 1500' within Airport boundaries.

6. In no event should helicopters arriving/departing the airport maintain less than 500' outside of the Airport boundaries.

PLEASE FOLLOW ALL APPLICABLE PROCEDURES UNLESS WEATHER, TRAFFIC, ATC, OR AIRCRAFT OPERATING PARAMETERS DICTATE OTHERWISE.

BUREAU OF AERONAUTICS 4100 DONALD DOUGLAS DR 90808 (213) 421-8293 • BUREAU OF ENGINEERING 333 W OCEAN BLVD 90802 (213) 590-6383 • BUREAU OF PARKS 2760 STUDEBAKER RD 90815 (213) 421-9431 • BUREAU OF PUBLIC SERVICE 1601 SAN FRANCISCO AVE 90813 (213) 432-8904

Long Beach Tower, Long Beach Police Department, Los Angeles County Sheriff's Department, City of Lakewood, Wright Airlift International, Inc., Loomis Aircraft, Heliflight Systems, Pacific Wing and Rotor, Briles Helicopter and Huntington Beach Police Department, Security Pacific National Bank

LETTER OF AGREEMENT

EFFECTIVE: August 15, 1980

SUBJECT: SPECIAL VFR AND VFR HELICOPTER OPERATIONS

1. PURPOSE. This letter of agreement establishes procedures for control of helicopters operating under VFR and Special VFR weather minimums within the Long Beach control zone.

2. CANCELLATION. The letter of agreement between Long Beach Tower, Long Beach Department of Aeronautics, Long Beach Police Department, Los Angeles County Sheriff's Department and City of Lakewood, subject: Special VFR and VFR Helicopter Operations, effective March 15, 1975, is canceled.

3. SCOPE. These procedures apply to operations within the Long Beach control zone and within the areas and routes depicted on the attachments to this letter. Use of these procedures is limited to pilots of those parties who are a signatory to this letter of agreement.

4. RESPONSIBILITY. All operators who have agreed to the use of these procedures shall assure that their pilots are familiar with and comply with these procedures.

5. GENERAL PROCEDURES.

a. Areas.

(1) These procedures shall be applied to those helicopters operating within the seven basic areas as depicted on Attachment E, numbered 1 through 7.

(2) Pilots shall obtain approval or necessary clearances from the Long Beach Tower prior to operating in, departing or transiting the depicted areas.

(3) Area 7 contains the instrument final approach course to the Long Beach Airport. Special VFR helicopter operations in this area are discouraged and not normally authorized.

(4) Helicopters shall not operate Special VFR east of the San Gabriel River until additional approval has been received from the Long Beach Tower.

Long Beach Tower, Long Beach Police Department, Los Angeles County Sheriff's Department, City of Lakewood, Wright Airlift International, Inc., Loomis Aircraft, Heliflight Systems, Pacific Wing and Rotor, Briles Helicopter and Huntington Beach Police Department, Security Pacific National Bank
EFFECTIVE: August 15, 1980

8. ROUTES.

The arrival and departure routes will be flown as depicted in Attachment A unless coordinated otherwise with Long Beach Tower.

a. The routes will begin/terminate within the helicopter pattern or at mid-field.

b. Those departures or arrivals from areas located within close proximity of a desired route may join or leave said routes without proceeding to the mid-field area.

c. Routes:

The routes described herein will be used for arrivals and departures. For aircraft operating in Special VFR conditions while in the control zone: - proceed along the prescribed route, maintain Special VFR conditions at or below 500 feet unless directed otherwise by ATC.

(1) South Redondo Route.

Proceed to/from the Long Beach Airport via Redondo Avenue from/to shoreline. (Due to terrain and for noise abatement, an altitude at or below 700 feet is recommended when clear of the Runway 25 Left downwind pattern.)

NOTE: During south traffic operations, flights proceeding to and from the south will use Lakewood Boulevard between Wardlow Road and the Lakewood Traffic Circle (VFR only).

(2) North Downey Route.

Proceed to/from the Long Beach Airport via an extended centerline of and via Downey Avenue from/to Alondra Boulevard.

NOTE: During south traffic operations at Long Beach Airport, helicopter operators will use the East Wardlow Route and Bellflower Boulevard for flights to and from the ~~[illegible]~~.
NORTH

(3) Wardlow (East/West Routes).

West - proceed to/from the Long Beach Airport via Wardlow Road from/to the Los Angeles River.

East - proceed to/from the Long Beach Airport via Wardlow Road from/to the San Gabriel River (605) Freeway.

NOTE: East - for noise abatement purposes, between the hours of 2200 and 0600 Local, in lieu of the East Wardlow Route, proceed to/from Long Beach Airport via Lakewood Boulevard and Carson Street from/to the San Gabriel River (605) Freeway.

d. Altitudes.

(1) All flights operating VFR on the arrival and departure routes shall maintain 500 feet MSL or below so as to be clear of the Long Beach airport fixed wing traffic patterns.

(2) All flights operating Special VFR within the Long Beach control zone shall maintain at or below 500 feet MSL unless otherwise approved by the Long Beach Tower.

10. ATTACHMENTS.

a. Attachment A - Area chart and helicopter routes.

b. Attachment B - Helicopter pad/lane sites.

c. Attachment C - Helicopter traffic pattern.

d. Attachment D - Special VFR airspace.

e. Attachment E - Long Beach control zone.

Long Beach Airport Helicopter Operators Letter of Intent
re: Noise Abatement

DRAFT

We, the primary helicopter operators at Long Beach Airport, agree to cooperate as much as possible in an effort to mitigate helicopter noise problems.

Although we are bound to follow the procedures outlined in the Letter of Agreement with the FAA Air Traffic Control Tower dated August 15, 1980, and must maintain safety as a primary consideration, we will to the greatest extent possible participate in the following noise abatement practices:

General

1) Participate in the FAA Airport Noise Compatibility (Part 150) study to be conducted during 1984
2) Participate on the Long Beach Airport General Aviation Noise Abatement Committee
3) Give consideration to mitigating the helicopter noise complaints called into the Airport, which shall be forwarded to each helicopter operator on a monthly basis by the Bureau of Aeronautics
4) Where possible, schedule use of quieter equipment during the more sensitive early morning and late evening hours

Flight Procedures

1) Other than for safety reasons or ATC direction, operations within the Airport Traffic Area shall never be below 500 ft MSL unless with airport boundaries
2) During all hours, with ATC approval and traffic permitting, helicopters shall climb to at least 1000 ft MSL prior to reaching the nearest residential area. The reverse shall apply for arrivals
3) During the hours of 8 pm - 8 am, ATC and traffic permitting, helicopters shall climb to a minimum of 1500 ft MSL within the airport boundaries prior to departure. The reverse shall apply for arrivals
4) When conducting practice ILS approaches, helicopters shall follow the standard missed approach procedures rather than an early break off
5) When possible, use N. Lakewood and W. Wardlow corridors rather than S. Redondo and E. Wardlow
6) When departing S. Redondo, continue over S. Redondo to the shoreline prior to break off
7) Traffic and ATC permitting, when conducting local operations, remain west of the mid-point of Skylands Golf Course and east of Cherry Ave. when west traffic is in use, and north of Spring Street and south of Carson Street when south traffic is being used

Wright Airlift

Permian

Frontier Pacific

Long Beach Police Department

Los Angeles County Sheriff Aero Bureau

Pacific Wing and Rotor

Air Logistics

Air National Guard
Los Alamitos

Acknowledged: FAA Air Traffic Control Tower

APPENDIX B

Helicopter Equipment Specifications

Manufacturers' equipment specifications for the helicopters used in the three tests and those identified during measurements of routine in-service flyover operations are shown below by helcopter model. (Manufacturers specifications were obtained from the 1983 Helicopter Annual published by Helicopter Association International, February 1983.)

Aerospatiale 355 F Twin Star

Manufacturer	Aerospatiale Helicopter Corporation 250C-20F
Power Plant	(2) Allison 250C-20F, 420 shp each
Main rotor diameter	35.1 ft.
Tail rotor diameter	6.1 ft.
Overall height	10.1 ft.
Net weight	2840 lbs.
Maximum take off weight	5071 lbs.
Vne	150 knots
Maximum cruising speeding at S/L	126 knots
Vertical rate of climb	N/A
HIGE	6,800 ft.
HOGE	7,700 ft.
Service ceiling	14,400 ft.
Range	(with standard fuel tanks) 400 nm.

Agusta 109A

Manufacturer	Construzione Aeronautiche Giovanni
Power plant	(2) Allison 250-C20B
Main rotor diameter	36.09 ft.
Tail rotor diameter	6.66 ft.
Overall height	10.82 ft.
Overall length	36.46 ft.
Net weight	3, 125 lbs.
Maximum takeoff weight	5,730 lbs.
Vne	168 knots
Maximum cruising speed at s/l	150 knots
Vertical rate of climb at s/l	1,820 fpm
HIGE	9,800 ft.
HOGE	6,800 ft.
Service ceiling	15,000 ft.
Range	341 nm.

Bell 206B Jetranger III

Manufacturer	Bell Helicopter Textron.
Power plant	(1) Allison 250-C20J
Main rotor diameter	33.25 ft.
Tail rotor diameter	5.33 ft.
Overall height	11.58 ft.
Overall length	39.08 ft.
Net weight	3200 lbs.
Maximum take off weight	3200 lbs.
Vne	130 knots
Maximum cruising speeding at S/L	111 knots
Vertical rate of climb	N/A
HIGE	12,800 ft.
HOGE	8,800 ft.
Service ceiling	13,500 ft.
Range	386 (@ 5000 ft.)

Bell 206L Long Range

Manufacturer	Bell Helicopter Textron
Power plant	(1) Allison 250-C30P
Main rotor diameter	37 ft.
Tail rotor diameter	5.41 ft.
Overall height	11.69 ft.
Overall length	42.71 ft.
Net weight	2200 lbs.
Maximum take off weight	4150 lbs.
Vne	133 knots
Maximum cruising speed at S/L	110 knots
Vertical rate of climb	1260 ft./min.
HIGE	16,500 ft.
HOGE	5,400 ft.
Service ceiling	20,000 ft.
Range	343 nm @ 5000 ft.
Shaft horsepower (SHP)	400
Rotor speed	394 RPM. AT 1005 THRUST
Number of blades	Main-2, tail-2

Enstrom F28 (data for F28C-2)

Manufacturer	Enstron Helicopter Corporation
Power plant	H10-360-EIBD Four-cylinder engine with Rajay Turbocharger, 205 h.p.
Main rotor diameter	32 ft.
Tail rotor diameter	4.78 ft.
Overall height	9.17 ft.
Overall length	27.67 ft.
Net weight	1528 lbs. normal, 2600 lbs. restricted
Maximum take off weight	2350 lbs.
Vertical rate of climb at S/L	1,150 FPM
HIGE	10,000 ft.
HOGE	N/A
Service ceiling	12,000 ft.
Range	386 (with standard fuel tanks) 235 nm

Hughes 300B (data for Hughes 300C)

Manufacturer	Hughes Helicopters, Inc.
Power plant	(1) Lycoming H10-360-D1A
Main rotor Diameter	26.83 ft.
Tail rotor	4.25 ft.
Number of blades	Main-2, tail 2
Overall Height	8.75 ft.
Overall length	30.83 ft.
Net weight	796 lbs.
Maximum take-off weight	1300 lbs.
Vne	103 knots
Maximum cruising speed at S/1	96 knots @ 75% power
Vertical rate of climb at S/1	1200 ft./min.
HIGE	8300 ft.
HOGE	6400 ft.
Service ceiling	14000 ft.
Range	209 nm.

Hughes 500D (data for Hughes 500E)

Manufacturer	Hughes Helicopter, Inc.
Power Plant	Allison 250-C20B
Main rotor diameter	26.41 ft.
Tail rotor diameter	4.58 ft.
Overall height	8.9 ft.
Overall length	30.5 ft.
Net weight	1450 lbs.
Maximum take-off weight	3000 lbs.
Vne	152 knots
Maximum cruising speed at S/L	139 knots
Vertical rate of climb at S/L	912 ft./min.
HIGE	8500 ft.
HOGE	6000 ft.
Service Calling	15,000 ft.
Range	287 nm.

Messerschmitt BO 105

Manufacturer	Messerschmitt-Boelkow-Blohm
Power plant	(2) Allison 250 C28C
Main rotor diameter	32.25 ft.
Tail rotor diameter	6.17 ft.
Overall height	10 ft.
Overall length	38.08 ft.
Net weight	2,931 lbs.
Maximum take-off weight	5,291 lbs.
Vne	145 knots
Maximum cruising speed at S/L	137 knots
Vertical rate of climb at S/L	1,820 fpm
HIGE	12,630 ft.
HOGE	10,830 ft.
Service ceiling	20,000 ft.
Range	290 nm.