Chapter Two
AVIATION NOISE

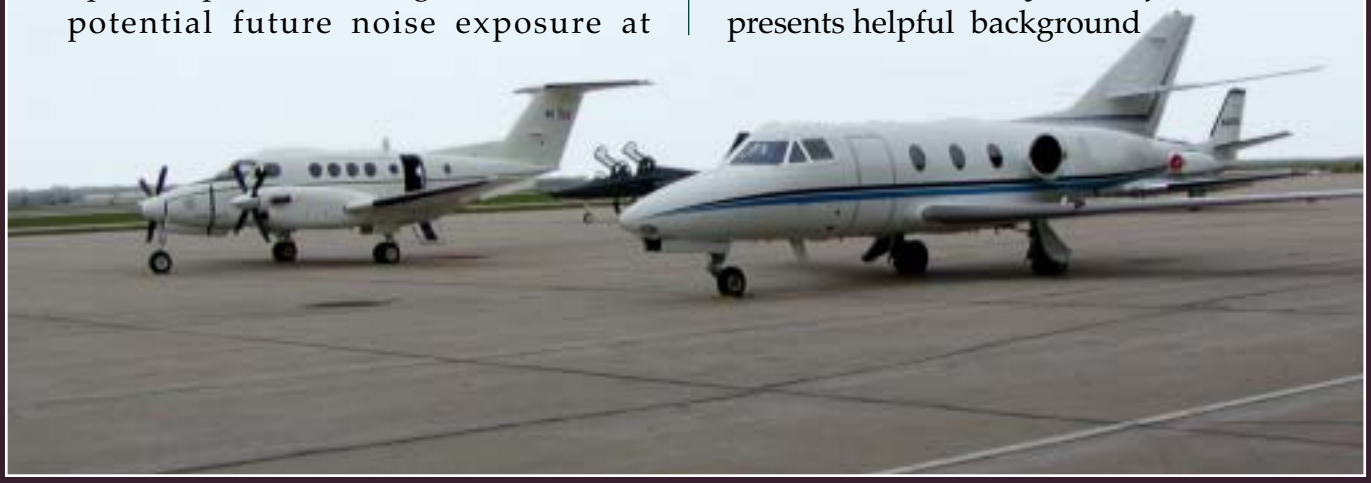
Aviation Noise

This chapter describes the noise exposure maps (NEM) for Lincoln Airport (LNK). Noise contour maps are presented for three study years: 2002, 2007, and 2022. The 2002 noise contour map shows the current noise levels based on operations for the latest twelve months of activity. The 2007 map is based on levels from the operation forecast outlined in the March 1999 Lincoln Airport Master Plan. The 2002 and 2007 maps are the basis for the official "Noise Exposure Maps" required under Federal Aviation Regulation (F.A.R.) Part 150.

The 2022 noise contour map was developed to present a long term view of potential future noise exposure at Lincoln Airport. Based on forecasts developed in the March 1999 Lincoln Airport Master Plan, these maps can be helpful in providing guidance for long term land use planning which is discussed at a later point in the Part 150 Study process.

These noise contour maps are considered baseline analyses. They assume operations based on the existing procedures at Lincoln Airport. No additional noise abatement procedures have been assumed in these analyses. The noise contour maps will serve as baselines against which potential noise abatement procedures will be compared at a later point in the study.

The noise analysis presented in this chapter relies on complex analytical methods and uses numerous technical terms. A ***Technical Information Paper (T.I.P.)*** included in the last section of this document, ***The Measurement and Analysis of Sound***, presents helpful background



information on noise measurement and analysis.

AIRCRAFT NOISE MEASUREMENT PROGRAM

A noise measurement program was conducted over a six-day period from May 6, 2002 through May 11, 2002. The field measurement program was designed and undertaken to provide real data for comparison with the computer-predicted values. These comparisons provide insight into the actual noise conditions around the airport and can serve as a guide for evaluating the assumptions developed for computer modeling.

It must be recognized that field measurements made over a 24-hour period are applicable only to that period of time and may not -- in fact, in many cases, do not -- reflect the average conditions present at the site over a much longer period of time. The relationship between field measurements and computer-generated noise exposure forecasts is analogous to the relationship between weather and climate. While an area may be characterized as having a cool climate, many individual days of high temperatures may occur. In other words, the modeling process derives overall average annual conditions (climate), while field measurements reflect daily fluctuations (weather).

Information collected during the noise monitoring program included 24-hour measurements for comparison with computer-generated DNL values. DNL -- day-night sound level -- is a measure of cumulative sound energy during a 24-hour period. All noise occurring from 10:00 p.m. to 7:00 a.m. is assigned a 10 decibel (dB) penalty because of the greater annoyance typically caused by nighttime noise. Use of the DNL noise metric in airport noise compatibility studies is required by F.A.R. Part 150. Additional information collected on single event measurements is used as an indicator of typical dB and Sound Exposure Levels (SEL) within the study area as well as comparative ambient noise measurements in areas affected by aircraft noise. All procedures and equipment involved in the aircraft noise measurement program were performed pursuant to guidelines set forth by F.A.R. Part 150, Section A150.3.

ACOUSTICAL MEASUREMENTS

This section provides a technical description of the acoustical measurements which were performed for the Lincoln Airport F.A.R. Part 150 Noise Compatibility Study. Described here are the instrumentation, calibration procedures, general measurement set-ups, and related data collection items.

Instrumentation

Four sets of acoustical instrumentation, the components of which are listed in **Table 2A**, were used to measure noise. Each set consisted of a high quality microphone connected to a 24-hour environmental noise monitor unit. Each unit was calibrated to assure

consistency between measurements at different locations. A calibrator, with an accuracy of 0.5 decibels, was used for all measurements. At the completion of each field measurement, the calibration was rechecked, the accumulated output data was downloaded to a portable computer, and the data memories were cleared before the unit was placed at a new site. The equipment listed in **Table 2A** was supplemented by accessory cabling, windscreens, tripods, security devices, etc., as appropriate to each measurement site.

TABLE 2A
Acoustical Measurement Instrumentation

4	Larson Davis 820 Portable Noise Monitors and Preamplifiers
4	Larson Davis Model 2559 - ½" Microphones
1	Model CA250 Sound Level Calibrator
1	Portable Computer

Measurement Procedures

Two methods were used to attempt to minimize the potential for non-aircraft noise sources to unduly influence the results of the measurements. First, for single event analysis, minimum noise thresholds of 5 to 10 decibels (dB) greater than ambient levels were programmed into the monitor. This procedure resulted in the requirement that a single noise event exceed a threshold of 60 dB at each site. Second, a minimum event duration, longer than the time associated with ambient single events above the threshold (for example, road traffic), was set (generally at five seconds). The combination of these two factors limited the single events analyzed in detail to those which exceeded the preset threshold for longer than the preset duration. In spite of these efforts, contamination of single event data is always possible.

Although only selected single events were specially retained and analyzed, the monitors do, however, cumulatively consider all noise present at the site, regardless of its level, and provide hourly summations of Equivalent Noise Levels (Leq). Additionally, the equipment optionally provides information on the hourly maximum decibel level, SEL values for each event which exceeds the preset threshold and duration, and distributions of decibel levels throughout the measurement period.

Weather Information

The noise measurements taken during this study were obtained during a period of average, spring weather for the Lincoln area. On the first three days, weather conditions were generally considered to be adequate for aircraft using visual flight rules (VFR) which call for cloud ceilings greater than 3,000 feet above ground level (AGL), visibility greater than five miles, light winds, and temperatures in the low 70s. Winds

increased the last two days of the monitoring period to about 10-15 knots with occasional gusts up to 25 knots. Rainstorms occurred during this period with daily temperatures in the mid-50s. A severe thunderstorm with high winds and heavy rain occurred during the last night of noise monitoring.

Aircraft Noise Measurement Sites

Noise measurement sites are shown on **Exhibit 2A**. They were selected on the basis of background information, local observations during the field effort, and suggestions from airport management based on noise complaint history. Specific selection criteria include the following.

- Emphasis on areas of marginal or greater than marginal aircraft noise exposure according to earlier evaluations.
- Screening of each site for local noise sources or unusual terrain characteristics which could affect measurements.
- Location in or near areas from which a substantial number of complaints about aircraft noise were received, or where there are concentrations of people exposed to significant aircraft overflights.

While there is no end to the number of locations available for monitoring, the selected sites fulfill the above criteria and provide a representative sampling of the varying noise conditions in the airport vicinity. Two sites were measured for 120 hours, two sites for a 48-hour period, and four sites for a 24-hour period.

Site 1 is located on airport property approximately 1,200 feet south-southeast of the runway threshold. The location is situated slightly east of the extended centerline of Runway 17L-35R and was selected due to the likelihood that this area would receive regular arrival and departure traffic. The monitor was placed in a large undeveloped area along a drainage ditch inside the airport outer access road. This location created a distance buffer between West Adams Street and the monitor. The 24-hour Leq for the first day at Site 1 was 58.7 and 58.2 for the second day. The DNL level for this site was computed to be 62.4 for the first day and 58.7 for the second day.

Site 2 is located at the south end of the primary runway, 35L, on airport property approximately 1,200 feet from the threshold of Runway 35L. The location is approximately 50 feet south of the Service Road. The site is in an area that would likely receive regular arrival and departure overflight noise from the airport.

The equipment was set up in an open area next to a fenced-in area for the airport's MALSR (medium intensity approach lighting system with runway alignment indicator lights). The 24-hour Leq for Site 2 was 63.5. The DNL level for this site was computed to be 71.8.

01SP21-2A-05/24/02

N 1st St.
NW 12th St.
W. McKelvie Rd.
NW 27th St.
NW 40th St.
NW 56th St.
W. Fletcher Ave.
W. Adams Rd.
W. Holdrege St.
NW 48th St.
W. Vine St.
W. O St.
W. A St.
SW 40th St.
W. VanDorn St.
SW 56th St.
S. Folsom St.
S. Coddington Ave.
W. Cornhusker Hwy
34
180
80
77
6
2
55
11
1
2
3
4
5
6
7

LEGEND

- Airport Property
- Municipal Boundaries
- Extraterritorial Jurisdiction
- Railroad Tracks
- Study Area
- Noise Monitor Location
- Low Density Residential (0-3 du/ac)
- Medium Density Residential (3.1-10 du/ac)
- High Density Residential (10.1+ du/ac)
- Floodplains
- Noise Sensitive
- School
- Library
- Historic Structures
- Places of Worship

Source: Base Information and Map:
City of Lincoln Geographic
Information System, May 2002.
Coffman Associates Analysis.

NORTH

0 4000
SCALE IN FEET

Lincoln Airport

Exhibit 2A
NOISE MONITORING LOCATIONS

Site 3 is located off the end of Runway 17L, approximately 750 feet north of the runway, on centerline. The equipment was set up in an area next to the service road going around the north end of the airport. Several general aviation aircraft arrivals were observed entering a final approach to Runways 17L and 17R both during monitor set-up and removal. The 24-hour Leq for the first day at Site 3 was 60.7 and 57.9 for the second day. The DNL level for this site was computed for the first day at 65.8 and 59.2 for the second day.

Site 4 is located off the end of Runway 17R, approximately 1,100 feet north of the runway, on centerline. The equipment was set up in an area next to the airport's MALSR. T-38 aircraft touch-and-go operations were observed during the set-up of the equipment. The 24-hour Leq for the first day at Site 4 was 60.2, 71.8 the second day, 75.4 the third day, and 63.4 the fourth day. The DNL level for this site was computed for the first day at 63.2, 72.1 the second day, 75.7 the third day, and 66.2 the fourth day.

Site 5 is located at 5324 Madison St., in the rear yard, approximately 8,650 feet west of the airport. The site is a single family residential area. The site is in an area that would likely receive regular overflight noise from the airport. The equipment was set up in the rear yard of the residence 30 feet from the home. A dog barking and several KC-135 overflights to the west of the residence were observed during monitor set-up. The 24-hour Leq for Site 5 was 43.3. The DNL level for this site was computed at 50.3.

Site 6 is located at 801 NW 40th St., approximately 5,650 feet west of centerline and 240 feet south of Runway 17R-35L. The area is a single family home surrounded by agriculture. The equipment was set up near the residence barn, approximately 150 feet from the residence. No aircraft overflights were observed during the monitor set-up. The 24-hour Leq for Site 6 was 49.3. The DNL level for this site was computed at 49.5.

Site 7 is located at 1838 SW 33rd St., approximately 11,200 feet south and 210 feet west of Runway 17R-35L centerline. The area is single family residential. The equipment was set up on the south side of the residence, approximately 70 feet from the road. During the equipment set-up, several aircraft overflights were observed. The 24-hour Leq for Site 7 was 51.3. The DNL level for this site was computed at 57.3.

Site 8 is located at 5533 NW 10th St., approximately 4,000 feet north and 4,500 feet east of Runway 17L-35R centerline. The area is single family residential. The equipment was set up in the rear yard of the residence, approximately 30 feet from the residence. No aircraft overflights were observed during the monitor set-up. The 24-hour Leq for Site 8 was 46.3. The DNL level for this site was computed at 53.9.

MEASUREMENT RESULTS SUMMARY

The noise data collected during the measurement period is presented in **Table 2B**. The information includes the average 24-hour Leq for each site. The Leq metric is derived by accumulating all noise during a given period and logarithmically averaging it. It is similar to the DNL metric except that no extra weight is attached to nighttime noise. The DNL (24) value represents the DNL from all noise sources.

In addition, L(50) values for each site are presented. These values represent sound levels above which 50 percent of the samples were recorded.

TABLE 2B
Measurement Results Summary
Lincoln Airport

	Site 1		Site 2	Site 3		Site 4				Site 5	Site 6	Site 7	Site 8
	Day 1	Day 2	Day 4	Day 1	Day 2	Day 1	Day 2	Day 3	Day 4	Day 3	Day 3	Day 5	Day 5
Measurement Dates	6-7 May	7-8 May	9-10 May	6-7 May	7-8 May	6-7 May	7-8 May	8-9 May	9-10 May	8-9 May	8-9 May	10-11 May	10-11 May
Cumulative Data													
LEQ (24)	58.72	58.29	63.59	60.73	57.93	60.21	71.89	75.49	63.45	43.39	49.37	51.38	46.35
DNL (24)	62.46	58.76	71.89	65.83	59.2	63.24	72.1	75.7	66.23	50.38	49.53	57.34	53.99
L (50)	50.8	50.8	52.2	49.4	49.4	50.1	50.1	50.1	45.8	41.9	52.1	44.9	49.7
Single Event Data													
L(max)	92.1	94.9	99.5	97	88.5	99.5	113.2	113.2	102.3	75.4	83.7	90.3	94.1
SEL(max)	98.3	100.1	102.5	101.5	97.7	102.8	115.9	115.9	106.5	82.9	92.4	92.1	99
Max Duration (sec)	235.65	178.65	108.56	373.15	1064.62	44.5	88.75	58.87	50.84	28.4	83.34	267.59	1166.34
Number of Single Events above 60 dB (Lmax)	224	151	133	685	581	210	280	634	415	43	180	127	149
Number of Nighttime Single Events above 60 dB (Lmax)	34	9	50	197	79	25	82	38	79	9	3	103	61
Number of Single Events Above													
SEL 70 dB	185	124	106	514	443	202	265	489	410	34	121	107	93
SEL 80 dB	81	61	57	105	83	51	78	205	53	4	9	22	13
SEL 90 dB	16	13	35	21	7	17	60	58	23	0	2	2	1
SEL 100 dB	0	1	6	1	0	2	29	32	4	0	0	0	0

Source: Coffman Associates analysis.

The table also presents data on other measures of noise that may be useful for comparisons. These include:

- Maximum recorded noise level in dB (Lmax);

- Maximum recorded sound exposure level (SELmax);
- Longest single event duration in seconds (Max Duration); and
- Number of single events above SEL 70, 80, 90, and 100.

For comparative purposes, normal conversation is generally at a sound level of 60 decibels while a busy street is approximately 70 decibels along the adjacent sidewalk.

The program resulted in a total of 8,230 single events were recorded during the program and 384 average hourly sound levels were calculated and recorded.

AIRCRAFT NOISE ANALYSIS METHODOLOGY

The standard methodology for analyzing the prevailing noise conditions at airports involves the use of a computer simulation model. The Federal Aviation Administration (FAA) has approved the Integrated Noise Model (INM) for use in F.A.R. Part 150 Noise Compatibility Studies. The latest versions of the INM are quite sophisticated in predicting noise levels at a given location, accounting for such variables as airfield elevation, temperature, headwinds, and local topography. INM Version 6.0c was used to prepare noise exposure maps for the Lincoln Airport noise analyses.

Inputs to the INM include runway configuration, flight track locations, aircraft fleet mix, stage length (trip length) for departures, and numbers of daytime and nighttime operations by aircraft type. The INM provides a database for general aviation aircraft which commonly operate at Lincoln Airport. **Exhibit 2B** depicts the INM input assumptions.

The INM computes typical flight profiles for aircraft operating at the assumed airport location, based upon the field elevation, temperature, and flight procedure data provided by aircraft manufacturers. The INM will also accept user-provided input, although the FAA reserves the right to accept or deny the use of such data depending upon its statistical validity.

The INM predicts noise levels at a set of grid points surrounding an airport. The numbers and locations of grid points are established during the INM run to determine noise levels in the areas where operations are concentrated, depending upon the tolerance and level of refinement specified by the user. The noise level values at the grid points are used to prepare noise contours, which connect points of equal noise exposure. INM will also calculate the noise levels at a user-specified location, such as noise monitoring sites.

INM INPUT

AIRPORT AND STUDY AREA DESCRIPTION

The runways were input into the INM in terms of latitude and longitude, as well as elevation. As previously mentioned, the INM computes typical flight profiles for aircraft operating at the airport location, based upon the

field elevation, temperature, and flight procedure data provided by aircraft manufacturers. The Lincoln Airport's field elevation is 1,219 feet above mean sea level (MSL) and its average annual temperature is 50.8 degrees Fahrenheit (F).

It is also possible to incorporate a topographic database into the INM, which allows the INM to account for the changes in distances from aircraft in flight to elevated receiver locations. Topographic data from the U.S. Geographical Survey was used in the development of the noise exposure contours for Lincoln Airport.

ACTIVITY DATA

Noise evaluations made for the current year (2002) are based on operational counts from the Lincoln ATCT (airport traffic control tower) from May 2001 to April 2002. Five-year (2007) and long-term (2022) contour sets were prepared based upon forecasts presented in the March 1999 Lincoln Airport Master Plan. Existing and forecasted annual operations are summarized in **Table 2C**.

TABLE 2C
Operations Summary
Lincoln Airport

		FORECASTS	
Operations	**Existing 2002[1]**	**2007[2]**	**2022[2]**
Itinerant Operations			
Commercial	13,982	13,940	20,020
Air Taxi	6,886	5,900	7,000
Military	12,628	17,000	17,000
General Aviation	40,377	45,000	57,000
Total Itinerant	73,873	81,840	101,020
Local Operations			
Military	5,923	8,000	8,000
General Aviation	22,490	38,000	43,000
Total Local	28,413	46,000	51,000
Total Operations	***102,286***	***127,840***	***152,020***

[1] Year 2002 operations are based on ATCT counts from May 2001 to April 2002.
[2] Lincoln Airport Master Plan, March 1999.