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FIELD STUDIES OF THE AIR FORCE PROCEDURES (NOISECHECK) FOR MEASURING COMMUNITY NOISE EXPOSURE FROM AIRCRAFT OPERATIONS

R. A. LEE

MARCH 1982

AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY
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FOR THE COMMANDER

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This report describes the results of noise measurements at Laughlin AFB and Homestead AFB to field test the NOISECHECK equipment and procedures developed under contract by Bolt, Beranek and Newman, Inc. and Digital Acoustics Inc. NOISECHECK is the equipment and procedures used by the Air Force to spot check or validate the long term noise exposure predicted by NOISEMAP, the Air Force computer program for predicting community noise exposure from aircraft operations. (over)

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20. ABSTRACT (Continued)

The total noise exposure level at a specified location has an uncertainty associated with it whether the level is predicted or measured. The purpose of NOISECHECK is to determine the total noise exposure in terms of the Day-Night Level (DNL) metric for a specified ground location from direct measurements. NOISEMAP predicts DNL values for yearly-averaged "busy days" aircraft operations. Therefore, the direct DNL measurements need to be normalized to this "busy day" DNL. The NOISECHECK Procedures lead you through these normalizations in a straightforward step-by-step method. The results of the Laughlin and Homestead tests show that, with the proper data collection, the NOISECHECK procedures can validate the long-term noise exposure and explain any differences between the NOISEMAP predicted DNL values and the short term measurement DNL values.

SUMMARY

This report describes the results of noise measurements at Laughlin and Homestead AFB to field test the NOISECHECK equipment and procedures developed under contract by Bolt, Beranek and Newman, Inc. NOISECHECK is the equipment and procedures required to spot check or validate the long term noise exposure predicted by NOISEMAP, the USAF computer program for predicting the noise exposure from aircraft operations.

The first field study was done at Laughlin AFB to validate the high noise exposure levels, 80 dB and 75 dB Day Night Levels (DNL), in a high air traffic density area. The data at Laughlin showed good agreement at one location and a definite disagreement at two other sites between the measured and NOISEMAP predicted values. This discrepancy could not be resolved due to inadequacy of the aircraft operational data collected, although a probable cause is discussed. At Homestead AFB due to careful collection of the logs of the aircraft operations, we were able to use the recommended NOISECHECK procedure of synthesizing the DNL from measured SELs to find out what causes the differences between measured and NOISEMAP predicted DNLs. After correcting the erroneous operation inputs to NOISEMAP discovered by this procedure, we had excellent agreement at both measurement locations.

This report shows that with the proper pre-field test planning and data acquisition techniques, NOISECHECK can effectively determine if there are differences between long-term predicted values and short-term measured values of total noise exposure and what caused the differences. This report also proposes a method for increasing the security of the monitors (a serious and potentially expensive problem with any unattended unit) and for simplifying the NOISECHECK procedures. This new simplified procedure will reduce by one-half the work to prepare for a field test, will provide a screening method for data collection at each site, and help simplify the data analysis.

PREFACE

This report was prepared by the Biodynamic Environment Branch (AFAMRL/BBE), Aerospace Medical Research Laboratory, under Air Force Systems Command Project/Task 723107, Technology To Define and Assess Environmental Quality of Noise From Air Force Operations. The author of this report gratefully acknowledges the personal interest and efforts of Mr. Dwight Bishop, the principle author of the NOISECHECK procedures report on which this report is based, Mr. Jerry Speakman who assisted in the field measurements and Mrs. Norma Peachey who typed this report.

TABLE OF CONTENTS

		Page
I	INTRODUCTION	8
II	EQUIPMENT CHECKOUT	9
III	LAUGHLIN AFB STUDY	13
	Test Preparation	13
	Data Collection	16
	Data Analysis	17
	1. Direct Measurement DNL Analysis	20
	2. Calculated DNL From Measured SELs	21
IV	HOMESTEAD AFB STUDY	39
	Test Preparation	39
	Data Collection	42
	Data Analysis	43
	1. Direct Measurement DNL Analysis	43
	2. Calculated DNL From Measured SELs	44
V	CONCLUSIONS AND RECOMMENDATIONS	63
APPENDIX A	LAUGHLIN AFB DATA	67
APPENDIX B	HOMESTEAD AFB DATA	87
APPENDIX C	RANGE ORDERING OF DNL CONTRIBUTORS AT A SITE	98
APPENDIX D	BLANK WORKSHEETS AND SUPPLEMENTAL EQUATIONS	108

LIST OF FIGURES

Figure		Page
1	Noise Contours, Flight Tracks and Proposed Measurement Sites for Laughlin AFB TX	14
2	Significant Flight Tracks For Laughlin AFB TX	15
3	Number of Measurements Needed To Assure A 90% Confidence Interval	19
4a	Laughlin AFB Worksheet 9 for Site 2	24
4b	Laughlin AFB Worksheet 9 for Site 3	25
4c	Laughlin AFB Worksheet 9 for Site 4	26
5	Adjustment For Measurement DNL To Average Busy Day Operations For Laughlin AFB	27
6a	Laughlin AFB Worksheet 1 For Site 2	28
6b	Laughlin AFB Worksheet 1 For Site 3	29
6c	Laughlin AFB Worksheet 1 for Site 4	30
7a	Laughlin AFB Worksheet 5 For Site 2	31
7b	Laughlin AFB Worksheet 5 For Site 3	32
7c	Laughlin AFB Worksheet 5 For Site 4	33
8a	Laughlin AFB Worksheet 6 For Site 2	34
8b	Laughlin AFB Worksheet 6 For Site 3	35
8c	Laughlin AFB Worksheet 6 For Site 4	36
9	Noise Contours, Planned Urban Development and Measurement Locations For Homestead AFB FL	40
10	Dominant Flight Tracks At Homestead AFB	41
11a	Homestead AFB Worksheet 9 For Site 1	47
11b	Homestead AFB Worksheet 9 For Site 2	48
12	Adjustment For Measurement DNL To Average Busy Day Operations For Homestead AFB	49
13a	Homestead AFB Worksheet 1 For Site 1	50

13b Homestead AFB Worksheet 1 For Site 2 51

14a Homestead AFB Worksheet 5 For Site 1 (Measured DNL Analysis) 52

14b Homestead AFB Worksheet 5 For Site 2 (Measured DNL Analysis) 53

15a Homestead AFB Worksheet 6 For Site 1 (Measured DNL Analysis) 54

15b Homestead AFB Worksheet 6 For Site 2 (Measured DNL Analysis) 55

16 Event Correlation For Sept 14 Logs At Homestead AFB . . 56

17a Homestead AFB Worksheet 3 For Site 1 57

17b Homestead AFB Worksheet 3 For Site 2 58

18a Homestead AFB Worksheet 4 For Site 1 59

18b Homestead AFB Worksheet 4 For Site 2 60

19a Homestead AFB Worksheet 6 For Site 1 (Measured SEL Analysis) 61

19b Homestead AFB Worksheet 6 For Site 2 (Measured SEL Analysis) 62

20 Proposed Noise Monitor Security Cases 65

21 LDN_i Summary Sheet 66

C-1 Example of Worksheet 7 Filled Out For KC-135A 101

C-2 Example of NOISEMAP Chronicle For KC-135A 103

D-1 Worksheet 1 Calculation of Daily DNL 109

D-2 Worksheet 2 Noise Level Log 111

D-3 Worksheet 3 SEL Computation Sheet 112

D-4 Worksheet 4 Computed DNL and Confidence Interval From Measured SELs 114

D-5 Worksheet 5 Calculation of NOISEMAP Confidence Intervals and Standard Deviation 116

D-6 Estimate of NOISEMAP Variance 118

D-7 Worksheet 6 Calculation of Probability of Consistency . 119

D-8 Worksheet 7 NOISEFILE SEL Summary 121

D-9 Worksheet 8 Calculation of Slant Distance and Aircraft SEL At Sites 122

D-10 Worksheet 9 Estimation of the Relative Importance of Operations At A Site 124

LIST OF TABLES

Table		Page
1	Regrouped Rank Ordered DNL Main Contributors At Laughlin AFB	37
2	Measured SELs and Altitudes At Laughlin AFB	38
A-1	Hourly Noise Levels at Laughlin AFB	68-77
A-2	Temperature and Relative Humidity At Laughlin AFB	78-80
A-3	RSU Observer Flight Track Utilization Counts	81
A-4	Total Base Traffic Count At Laughlin AFB	82
A-5	T-38 Daily Operations	83
A-6	T-37 Daily Operations	84
A-7	Pilot Summary of Operating Parameters At Point of Closest Approach To Microphone Locations	85
A-8	Summary of Altitude Verification From Photos	86
B-1	Hourly Noise Levels At Homestead AFB	88-93
B-2	Temperature and Relative Humidity At Homestead AFB	94-95
B-3	Operations Logged By Base Operations At Homestead AFB	96
B-4	F-4 Aircraft Parameters From Standard Evaluation	97
B-5	Slant Distance Verification By Photos	97
D-1	The Relationship of Parameters P and Z	126

I. INTRODUCTION

A vital part of Air Force environmental noise planning efforts is the need to perform spot-check noise measurements which provide data supporting predicted noise exposure values and the corresponding decisions made regarding land use compatibility and environmental noise impact. The objective of this effort was to field test, evaluate and modify, if needed, the aircraft noise monitoring technology developed under Air Force contract #F33615-77-C-0514 by Bolt Beranek and Newman Inc. This technology will be used by the Air Force in collecting field measured noise exposure data acceptable as evidence in cases involving extreme controversy or litigation.

This report details the two field tests that were conducted to evaluate this NOISECHECK technology. The first test was conducted at Laughlin AF Base, an Air Training Command base, located near Del Rio, Texas. The second test was conducted at Homestead AFB, a Military Airlift Command base, located near Homestead, Florida. The two bases are typical of the differences in aircraft number and mix that occur at the various Air Force bases. Laughlin AFB has two main aircraft with the T-37s dominating the noise exposure on the west side of the base and the T-38s on the east side. At Homestead, the F-4s dominated the total noise exposure everywhere. Other major differences at the two bases include the following: (1) The T-38 and T-37 aircraft at Laughlin AFB were considerably quieter than the F-4 aircraft at Homestead AFB; (2) Laughlin AFB averaged about 360 T-38 and 300 T-37 aircraft operating per day, while Homestead averaged about 100 F-4 operations per day; (3) Detailed daily records of the F-4 operations on individual flight tracks were available at Homestead AFB, whereas only the total daily tower traffic count was available at Laughlin due to the large number of operations per day. Since all AF bases exhibit similar kinds of differences, it was found that the NOISECHECK measurements and procedures need to be custom formed for each base, site and purpose following a general procedure.

This report is structured around the four main stages of a typical NOISECHECK test (test preparation, data acquisition, data analysis, and test analysis). The two tests are detailed separately, Laughlin first then Homestead, to show the difference in approaches used for the two tests. At Laughlin we were attempting to refine the NOISECHECK procedures into cookbook form to be used at all bases by non-experienced personnel. When we did the study at Homestead about seven months later we realized that this was not practical. We then used the approach of refining a general procedure that would be tailored for each specific base/site/purpose by personnel knowledgeable about the NOISEMAP program and experienced in making measurements of total noise exposure.

II. EQUIPMENT CHECKOUT

Before conducting any NOISECHECK test, the equipment should be examined to make sure it is in proper operating condition. Following is a simple checkout procedure that can be used to determine if all aspects of the NOISECHECK units are operational.

NOISECHECK programs involve a basic noise-monitoring unit: Digital Acoustics DAI 607P. It comprises a standard sound level meter with built-in digital computing and memory capabilities and a printer. This unit can process, store, and print-out either single-event or continuous noise exposure data. Print-out of Hourly Noise Level (HNL), Day Night Level (DNL) data, etc., can be on demand or at specified intervals.

The digital circuitry of the DAI 607P samples the electrical signal that would be fed to an indicating meter in a standard sound level meter eight times a second and then uses these sampled levels in digital computations. The output of this NOISECHECK unit is in two forms: an LED display for visual observation and printouts on a thermal printer for permanent records.

The DAI 607P has been designed for routine output of the Day Night Level (DNL) used for aircraft noise analyses. It also measures and prints out the Hourly Noise Level (HNL) as well as the Sound Exposure Level (SEL) and maximum A-level of individual noise events that rise above a selectable noise threshold. Incorporated in the unit is an accurate time clock, which records the time of day at which single events occur. The DAI 607P has the option to output percentile distribution functions of the measured A-level over specified time intervals, data which can be used for non-aircraft noise analyses.

A Gen Rad 1567 114 dB, 1000 Hz calibrator is used for the field calibration of the DAI 607P. This NOISECHECK monitor has a built-in safeguard so that no data will be taken unless the system is first calibrated.

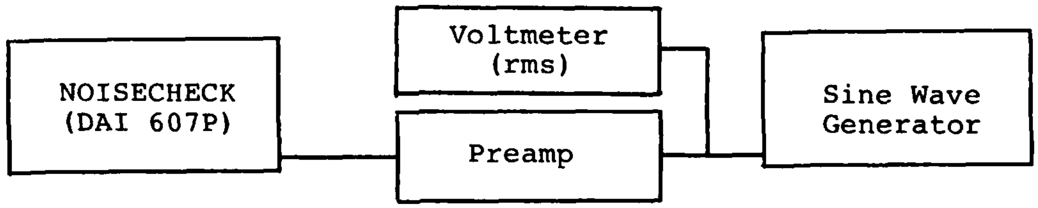
The microphone is a Gen Rad 1962-9601, an electret form of a condenser-type microphone. This microphone was chosen for NOISECHECK programs because they have moderate sensitivity and excellent frequency response, and they can tolerate a wide range of operating conditions.

A microphone windscreen of porous foam is provided not only to reduce the noise of wind but also to protect the microphone from rain and snow.

Because the electrical signals generated by the microphone are small, it is attached directly to a preamplifier, a stable, low self-noise, electrical amplifier that transmits the enhanced electrical signal over a cable to the DAI 607P.

The checkout of the NOISECHECK equipment can be accomplished in any electronics lab using only two pieces of standard equipment, an rms voltmeter and a sine wave generator. A description of the NOISECHECK keyboard is detailed in the NOISECHECK procedures report (Ref. 1). The NOISECHECK equipment was verified to be in proper working order prior to our field use by using the following procedure:

Set up NOISECHECK instrumentation as follows:



A. CALIBRATION

1. Set Generator at 1000 Hz, 1 volt rms
2. Turn NOISECHECK instrument on (on, A-weighting, fast)
3. Wait 30 seconds
4. Press (set, 9, enter, read, 1, enter)
   Display should read 114.0 dB
5. Press (print, 0, enter)
   System should printout system status

B. FREQUENCY WEIGHTING CHECK

1. Press (print, 11, enter)
2. Set Generator at 50 Hz, 1 volt rms
3. Press (read, 1, enter)
   Display should read 83.8 dB*
4. Set switch to flat
5. Press (read, 1, enter
   Display should read 112.7*

---

1. Bishop, D. E., Harris, A. S., Mahoney, J., Rentz, P. E.: NOISECHECK Procedures for Measuring Noise Exposure From Aircraft Operations, AFAMRL-TR-80-45, Nov 1980.

6. Repeat steps 2 through 5 for the following values:

Frequency	A-Weightings Should Read:	Flat Should Read:
100 Hz	94.9*	113.7*
500 Hz	110.8*	114.0*
1000 Hz	114.0*	114.0*
5000 Hz	114.5*	112.7*
10 KHz	111.5*	109.6*

* NOTE: Values should read within ±.5 dB.

C. DYNAMIC RANGE CHECK

1. Set Generator at 100 Hz, 2 volts rms
2. Set switch to A-weighting
3. Press (read, 1, enter)
   Display should read 120.0 dB
4. Disconnect the Generator and short the input to the preamp
5. Press (read, 1, enter)
   Display should read less than 5.0 dB

D. INTEGRATION CHECK

1. Press (print, 1, enter)
2. Set the Generator at 1000 Hz, 1 volt rms
3. Using a stopwatch connect the Generator for 100 seconds
   System should print-out: SEL = 134.0 dB
   MAX = 114.0 dB
4. Press (set, 19, enter, 40 enter)
5. Using a stopwatch connect the Generator for 2 seconds
   System should NOT print-out anything
6. Using a stopwatch connect the Generator for 6 seconds
   System should print-out SEL and MAX values
7. Press (set, 20, enter, 80, enter)
8. Using a stopwatch connect the Generator for 5 seconds, wait 5 seconds, then reconnect for another 5 seconds
   After 10 seconds system should print-out one SEL value with a duration greater than 15 seconds
9. Using a stopwatch connect the Generator for 5 seconds, wait 11 seconds, then reconnect for another 5 seconds
   System should print-out 2 SEL values each with a duration less than 10 seconds

E. DISTRIBUTION FUNCTION CHECK

1. Press (print, 11, enter, print, 6, enter, set, 8, enter, 0.01 enter, set, 23, enter)
   System should print-out L(x) values after 1 minute

2. Press (read, 40, enter)
   System should display time (mm, ss) on internal clock
3. When the clock starts a new minute interval, connect the Generator for 3 seconds
   Systems should print-out the L(x) values with only the L(.1) through L(5) values equal to 114.0 dB
4. Repeat steps 2 and 3 connecting the Generator for the following times:

6 seconds - only the L(.1) through L(10) values should = 114.0 dB
30 seconds - only the L(.1) through L(50) values should = 114.0 dB

54 seconds - only the L(.1) through L(90) values should = 114.0 dB
60 seconds - all L(x) values should equal 114.0 dB

5. Press (print, 16, enter)

F. ACOUSTIC LEVEL CHECK

1. Set switch to flat.
2. Disconnect voltmeter and sine wave generator.
3. Connect microphone to preamp.
4. Place GR 1567 calibrator on microphone.
5. Turn calibrator on.
6. Press (set, 9, enter, read, 1, enter)
7. Replace GR 1567 calibrator with B&K 4220 pistonphone.
8. Turn on pistonphone.
9. Press (read, 1, enter) system should display 124.0 dB ±.8 dB

TEST COMPLETE

If any tests fail, repeat the test. If test continues to fail, turn unit over to a qualified technician for repair.

III. LAUGHLIN AFB STUDY

Test Preparation

The NOISECHECK procedures report (Ref. 1) in pages 8 through 19 give a detailed synopsis of things that need to be considered when planning a NOISECHECK type test. It includes defining program goals, assembling pertinent information, estimating test duration and gives help for selecting the specific measurement sites.

After coordination with HQ ATC the initial checkout test for the NOISECHECK technology was scheduled at Laughlin AFB. The test was designed to model a litigation problem at Williams AFB that has similar flight operations to Laughlin. This problem at Williams AFB involved a person that wanted to develop his land by building residential dwellings within the Day Night Average Sound Level (DNL) 80 contour. The local Zoning Board refused to let him build because of the incompatibility of a noise environment over DNL 80 with residential property. The litigation involved the validity of the contours predicted by the USAF AICUZ (Air Installation Compatible Use Zone) Program. The developer claimed that it is not as noisy as the NOISEMAP program predicts and therefore he should be allowed to build.

Figure 1 shows the input flight tracks, the NOISEMAP contours and the proposed measurement locations for Laughlin AFB TX. The plan was to conduct the test over a two-week period with four NOISECHECK instruments. Since the DNL 80 contour on the takeoff end of the runway was the primary concern, monitors were to be placed at positions 3 and 4 for the full two weeks. These two monitors should be adequate to define the DNL 80 contour at that end of the runway due to the relatively small land area involved. The other two monitors were to be used for quick checks at the other locations. The monitors were to be placed at locations 1 and 2 for the first week and moved to 5 and 6 for the second week. Site 1 would be the hardest test for NOISEMAP due to the long propagation distance from the nearest flight tracks and the uncertainties in transition angle modeling. Sites 2, 5 and 6 would be used to check the DNL 75 contour closure at locations that would be under virtually all of the takeoff flight tracks.

With the large number of aircraft operations at Laughlin per day (approx. 350 operations/day) it would be very difficult for one person to associate each operation with all the various flight tracks. See Figure 1. The operations count was simplified by consolidating some flight tracks and only counting the operations over the measurement locations. The total number of tracks that were needed to count for this test was reduced to ten tracks (see Figure 2). These ten tracks are nicely divided with the four tracks for runway 31L used by the T-37 aircraft and the other six are almost exclusively used by the T-38 aircraft.

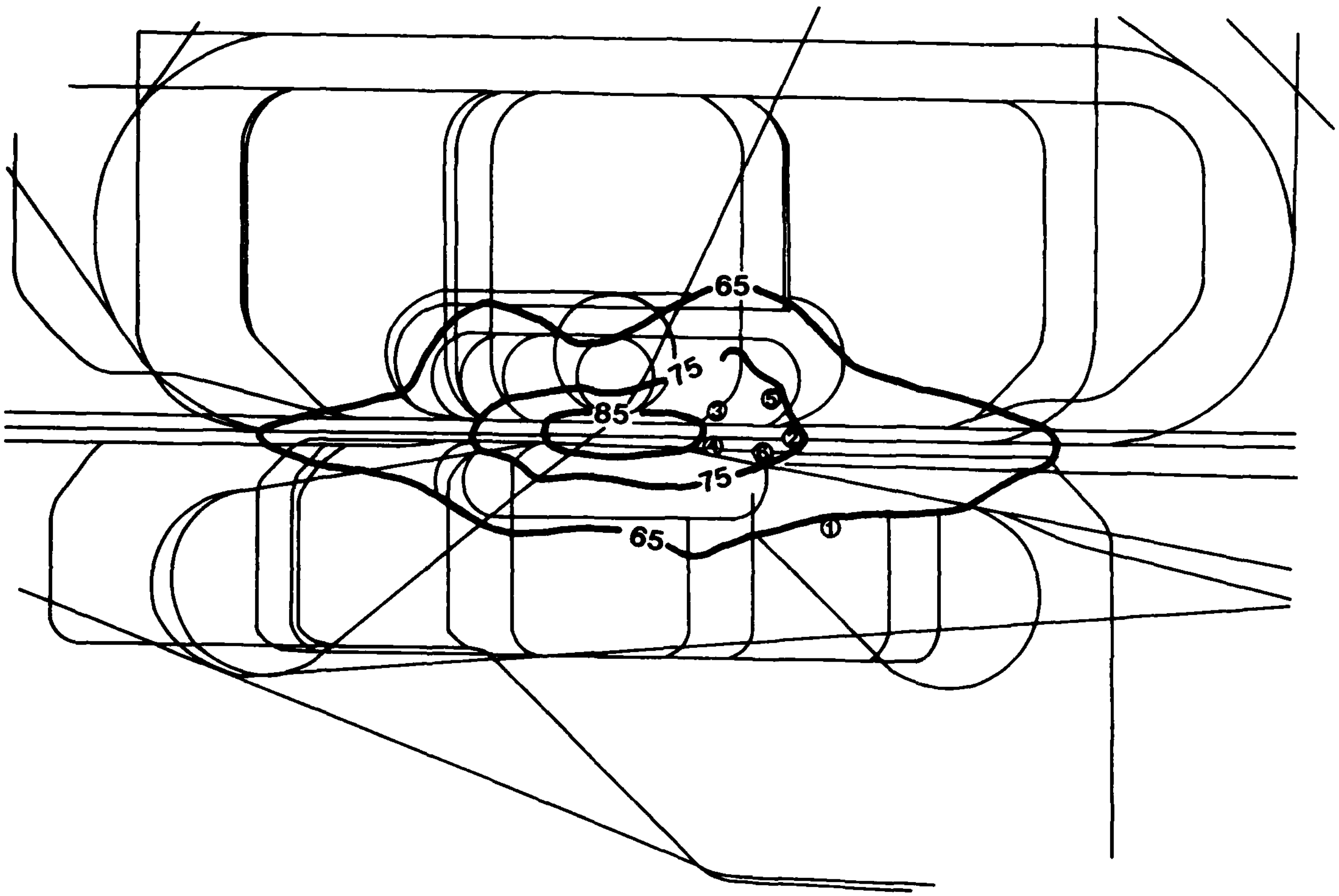


Figure 1. Noise Exposure Contours, Flight Tracks and Proposed Measurement Locations for Laughlin AFB, Texas

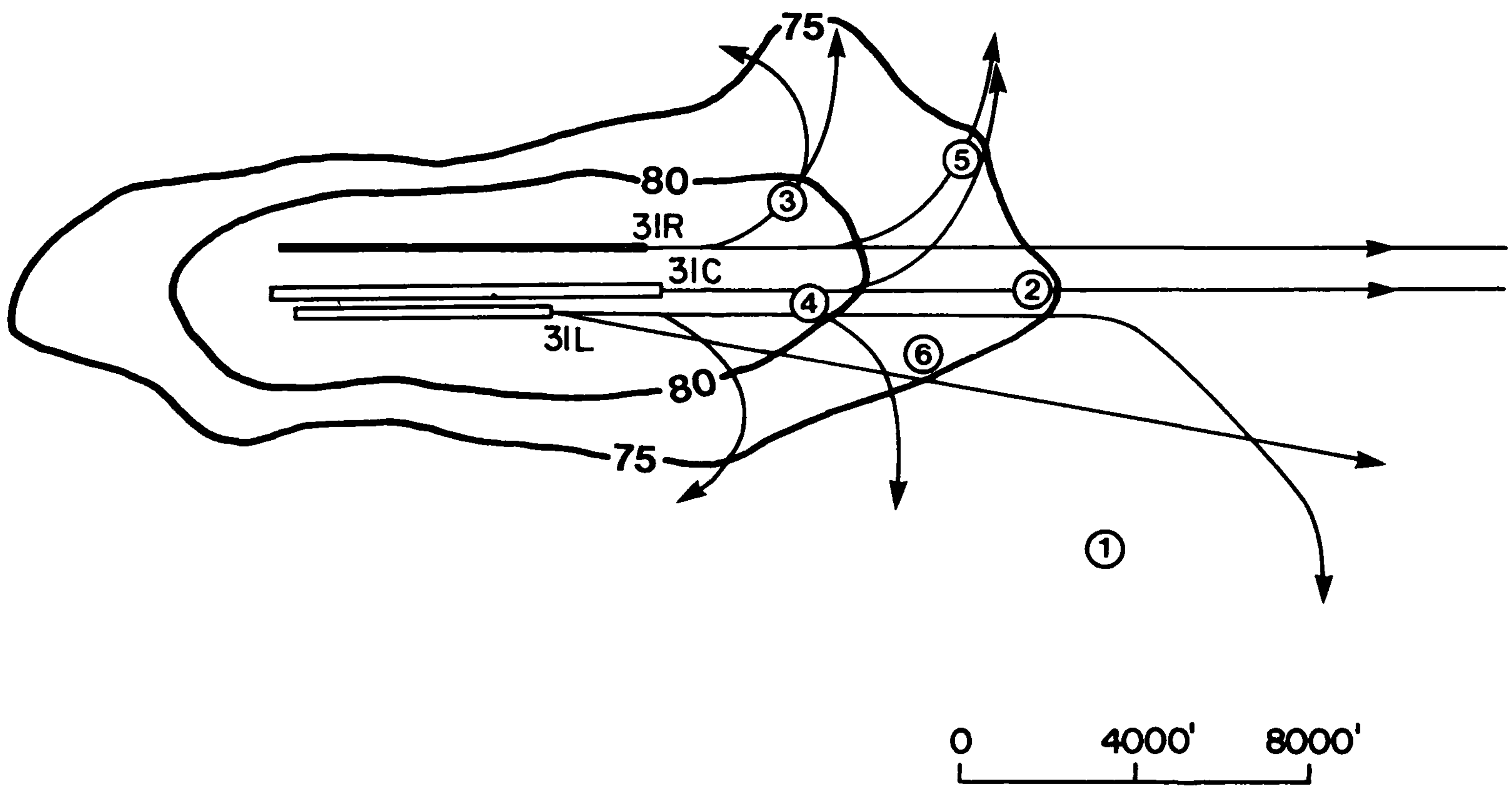


Figure 2. Significant Flight Tracks for NOISECHECK Test at Laughlin Air Force Base, Texas

A point of contact was established at Laughlin AFB in the Base Civil Engineer's Office, the office responsible for the base's input to NOISEMAP and the AICUZ program. A detailed test plan, AMRL/BBE-TP-29 was sent to our point of contact for coordination/ information of the Base Commander, Director of Maintenance, Air Traffic Controller, Security and the other base organizations. An orientation meeting was scheduled for the first day to explain the nature, scope and purpose of this study.

DATA COLLECTION AT LAUGHLIN AFB

Initial Setup

Several difficulties were encountered at Laughlin AFB during the first week of the measurement period. Although the measurement locations were known in advance, permission to place our monitors on private land was not obtained prior to the test. It took several days to locate the owners so it wasn't until Wednesday, 14 Feb 79, that the first monitors were put in the field. The next day the NOISECHECK Unit at Location 1 began malfunctioning. After recalibrating, the system worked for another half a day and then quit completely. (After the test, this unit was sent back to the manufacturer where it was learned the problem was a faulty memory chip.) This left us with monitors at Locations 2, 3 and 4 for the first full measurement day on Thursday. But Thursday afternoon the wind shifted enough to switch runways, so instead of the planes taking off, they were landing over our measurement locations. This adverse wind condition continued until the following Tuesday. This was causing our measurement period to not be representative of the yearly averaged operations at Laughlin, so the measurement period was extended another week and the plans to measure at Locations 5 and 6 were dropped. At the end of the second week the system at Location 2 began malfunctioning and no reliable data were acquired at that location after Thursday, February 22. Therefore, in the overall analysis of this test, it should be noted that these data from Location 2 will be for a different measurement period then data at Locations 3 and 4 and will be compared to NOISEMAP predicted values for different aircraft operations.

Collection of Acoustic and Weather Data

The NOISECHECK units were set to print-out hourly noise levels (HNL), community noise exposure levels (CNEL) and day-night levels (DNL) for the complete duration of the test. Sound exposure levels (SEL) were also acquired for a limited number of aircraft operations, when an operator was present to identify the particular operation. The operator annotated on the print-outs the particular operation which could then be time correlated with the other units. Table A-1 lists the HNLs, CNELs and DNLs collected from the monitors. Table A-2 lists the temperature and relative humidity during the test. The blocked-in areas of the weather table indicate the times when there were aircraft activity at any of the measurement locations.

Data Collection for Aircraft Operation Information

At Laughlin AFB the only record of aircraft operations was the traffic count figures kept by Base Operations. These figures were split out by T-37 and T-38 operations but there was no exact tabulation of aircraft operations by flight track. Since sufficient manpower was not available to do an exact count of aircraft operations by flight track for the entire test, a sampling method was used. A man stationed at the runway supervisory unit (RSU) located at each runway logged the aircraft into three categories - takeoff, crosswind and closed during busy times of the day. The utilization of flight tracks during these busy times was then applied to the T-38 and T-37 totals to come up with the totals by flight track to compare to the NOISEMAP chronicles. Table A-3 gives the flight track utilization as observed by the man in the RSU units. Table A-4 gives the daily traffic count collected for Base Operations. Note: The traffic count is exactly twice the number of operations that occur over one end of the runway; i.e., during a takeoff and landing we would have one event over the NOISECHECK units but the traffic count would be two. Tables A-5 and A-6 give the calculated daily operations and average busy day operations for the test period by flight track for direct comparison to the NOISEMAP inputs.

Engine power settings, airspeed and aircraft altitude at microphone locations were obtained by interviewing several pilots. Photos taken from the microphone location with the aircraft at the point of closest approach to the microphone were used to verify the aircraft altitude profiles. Table A-7 gives the pilots' summary of power setting, airspeed and altitude profile over the microphone locations. Table A-8 gives the altitude summary from the photographs.

Collection of this operations information was a very tedious and time consuming task due to the large number of flight tracks at Laughlin AFB. Even with consolidating flight tracks to the gross categories of straight-out, crosswind and closed departures, operations information was not verified for all situations. Where no information was obtained, it was assumed that the NOISEMAP inputs were representative of the test period. The difficulties encountered in trying to verify all noise sources during the test period have demonstrated the need for a screening process to limit the number of flight operations that need to be verified. A recommendation for determining the major contributors at a specific ground location will be discussed later in this report.

DATA ANALYSIS AT LAUGHLIN AFB

Background Information for Data Analysis

Any value of total noise exposure at a specified location has an uncertainty associated with it. This is true whether the value is predicted or measured. The purpose of NOISECHECK is to determine the total noise exposure in terms of the Day-Night Level (DNL) metric for a specified ground location from direct measurements. Although direct measurements of the DNL are appealing to most people as the firm number that a prediction should be compared to this is not necessarily true. If measurements were made of the DNL for a two week period the results would only be representative of the noise exposure for that measurement period. If measurements were made for another two week period, these two DNL values could and probably would be different. The NOISEMAP program predicts DNL values for the yearly averaged "busy day" aircraft operations. This yearly averaged busy day DNL is the value that we want the NOISECHECK measurements to represent.

The NOISECHECK procedures report (AFAMRL-TR-80-45) in pages 38 to 77 delineate the two procedures for analyzing the NOISECHECK data. The two procedures are the direct measurement DNL analysis and the calculated DNL from measured sound exposure levels (SEL) analysis. The direct measurement DNL analysis takes the daily DNL values measured by the NOISECHECK monitors and adjusts them to average busy day operations by adding the correction factor of 10 log (busy day operations daily operations). This method usually takes a long measurement period to obtain a specific confidence interval because you can usually only obtain five DNL values during a week's worth of measurements (most Air Force bases don't fly full operations on Saturday and Sunday). Figure 3 shows the number of measurements required to be 90% confident that the final DNL is within a specific interval for various amounts of scatter in the data. For example, if the measured DNLs had a 5 dB scatter, it would take 30 measurements (6 weeks) to obtain a direct measured DNL value that you could be 90% confident that the true busy day DNL was within a ±1.5 dB interval around the measured value or 65 measurements (13 weeks) to be within a ±1 dB interval.

Also, since DNL contributions by different aircraft or operations are not identified, less information is available to determine possible reasons for any sizable difference between measured DNL and the DNL computed from NOISEMAP.

The second method of analysis described in the NOISECHECK procedures report is to synthesize the DNL from measured SELs. Since you can obtain many SELs during a day's measurements, the amount of data is much greater than the measured DNLs. This method is required if the duration of the field measurement program is limited and reasons for possible discrepancies are desired. The analysis process consists of correlating portable noise level monitor SELs with individual operations from on-site logs or Tower Logs and combining the energy average of these measured SELs for a particular operation with the average busy day number of operations. The average busy day number of aircraft operations is the input to NOISEMAP so these

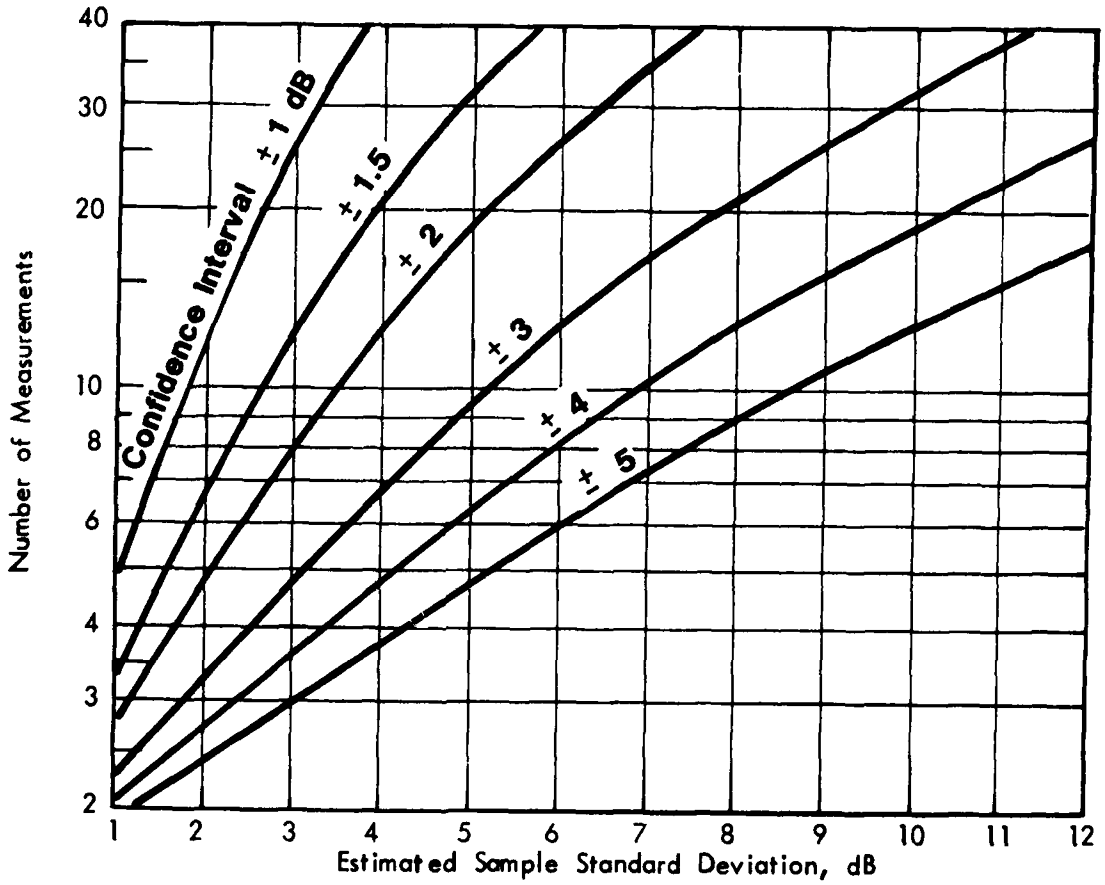


FIG. 3. NUMBER OF MEASUREMENTS NEEDED TO ASSURE A 90% CONFIDENCE INTERVAL. (From NOISECHECK Procedures Report: Ref. 1.)

numbers can be obtained from the NOISEMAP chronicles. It is important to note that the NOISECHECK technology does not attempt to determine what is the average busy day number of aircraft operations. This is left for the base AICUZ officer to determine, since there is no way that any two to three week survey can adequately determine yearly operation averages. Still it is incumbent upon the investigator to verify the operation inputs by interviewing several sources. For example, pilots, standard evaluation, the base AICUZ officer, Base Operations and tower personnel.

1. Direct Measurement DNL Analysis at Laughlin AFB TX

In order to fill out Worksheet 1 we need to determine the effective number of operations over each site on a daily basis during the measurement period and the NOISEMAP effective number of operations that contribute to that location's DNL value.

The base traffic count gives us the daily activity by runway. The tower count is the center runway activity which is 99% T-38 activity. Lariat Count is the east runway and is all T-38 activity. Honcho Count is the west runway and is all T-37 activity. By determining the major DNL contributors at each measurement location from NOISEMAP we can determine how much individual operations influence each measurement point. Since determining the major contributors at each location is the most important part of the NOISECHECK analysis, the section from the procedures report on rank ordering the DNL contributors at a site is included in Appendix C of this report. The list of DNL contributors for each measurement location at Laughlin AFB (Worksheet 9) are presented in Figures 4A - 4c. The flight track descriptor tells what runway is used. Runway 13 is a takeoff over the measurement locations and runway 31 is a landing over the measurement locations. C stands for the center runway, L for left, and R for the right runway. Therefore, 31R and 13L are the T-38 activity on the east runway, 31C and 13C are the center runway and 31L and 13R are the T-37s on the west runway. From these worksheets we can see that on an average busy day none of the three sites are affected significantly by any T-37 activity or any landings. Site 2 is dominated by the T-38 departures from the center runway and the crosswind patterns from the east runway. Site 3 is dominated by a mixture of all three T-38 operations, closed, crosswind and departure. Site 4 is dominated by the center runway departures. Figure 5 shows the effective number of dominant operations for an average busy day from the NOISEMAP inputs, the daily number of dominant operations from the tower count and the adjustment to be applied to the measured daily DNLs for each site. These adjustments are now input into the Worksheet 1s for each site (see Figures 6a - 6c). This worksheet then gives us the measurement DNL, the associated standard deviation and the 90% confidence intervals at each site. To compare these values with NOISEMAP we need to determine the NOISEMAP DNL, standard deviation and the 90% confidence intervals at each measurement location. Worksheets 7a - 7c give these values. Next we need to calculate the probability that the measured DNL and the NOISEMAP calculated DNL are consistent. Figures 8a - 8c (Worksheet 6s) give the probabilities for each location. The final results are summarized in the following table:

Laughlin AFB Site #	Measurement DNL DNL(M)	NOISEMAP DNL DNL(C)	Probability of Consistency
2	73.6	75.9	.0072
3	76.8	82.7	.0002
4	80.6	81.0	.7948

As can be seen, there is good agreement at Site 4, poor agreement at Site 2 and almost no agreement at Site 3. Although this analysis of the measured DNL shows disagreement with NOISEMAP, it cannot tell us what caused the problem. To find this out, we need a more detailed analysis using the SEL information collected by NOISECHECK.

2. Calculated DNL From Measured SEL Analysis at Laughlin AFB TX

The first step in synthesizing the DNL values from SELs is to identify the operations that produced each individual SEL. At the Laughlin AFB test the main contributors to the DNL were not determined prior to the test. This resulted in a lot of time spent documenting and identifying events that did not significantly contribute to a site's DNL (i.e., none of the T-37 activity was a major contributor at any of the measurement sites but amounted to about one-half of the operations data collected). Also, because of the large amount of aircraft activity the operations were grouped into gross categories that did not always match up with the NOISEMAP inputs. Although we had a man in the RSU units logging actual takeoff, crosswind and closed loop patterns for the T-38s, those could not be correlated with the NOISECHECK units. This was because the observer grouped activity into three minute time segments in order to keep up with the large amount of activity and at the monitor sites often the noise levels from one activity did not drop off before another started merging the levels together. Therefore, a synthesized DNL from SELs is not possible from the data collected at Laughlin. But some information can be gained by looking at the SELs that were identified for each location and these are presented in this section.

In order to compare SEL values that were measured to the NOISEMAP SEL values, we need to condense the NOISEMAP contributors into the same categories as the measured SELs and rank order them. For example, at Site 2 the top two main contributors are the T-38 departures on the center runway (Flt tracks 13CA & 13CG). They produce SEL values of 100.3 and 100.6 respectively. These we combine by taking the energy average of the SELs and adding the number of operations together to make the new operation called T-38 departure (Note: this will produce slight errors due to uneven numbers of operations but it is the only way to compare to the measured categories). This T-38 departure for Site 2 has an SEL of 100.5 and 178.9 effective operations. These regrouped flight tracks are rank ordered for each site and presented in Table 1. This rank ordering demonstrates the relative importance of individual SEL values. Table 2 compares the NOISEMAP predicted values for the important events at each site to the SELs that were identified from the NOISECHECK measurements. Table 2 also compares the slant distances that were input to NOISEMAP with the slant distances we measured using a photographic scaling technique from pictures taken at each site. Included in Table 2 are the number of events that were used to determine the measured values. Even with this scant amount of single event data, several things can be concluded. At Site 4 we had very good agreement between measured and NOISEMAP values and this is reflected in the single event levels. The T-38 departures were louder than predicted by only 1.7 dB. This can be explained by the slant distance difference. Although we only had one photograph that showed an altitude of 640 feet, the pilots we interviewed seem to agree that their altitude over Site 4 would be somewhere around 500 feet AGL. The NOISEMAP value is 900 feet AGL and explains why NOISEMAP would slightly underpredict the values. The opposite is true for the crosswind patterns from the left runway. The measured values are lower but the slant distance is further than the NOISEMAP values. These two offsetting situations make the combined noise exposure very close to the NOISEMAP values. The T-38 closed loop patterns seem to agree very well at this location. Site 4 shows the same close agreement in the SELs as in the DNL analysis.

At Site 3 the problem of not identifying the major contributors prior to the test was made clear. Although we documented numerous events at Site 3 we had no slant distance pictures and only one identified SEL for each of the two major contributors. This is unfortunate since Site 3 was where we had the largest discrepancy between measured and predicted values. From field observation we noticed that the closed loop patterns were turning quite a ways before Site 3 and NOISEMAP has that flight track coming within a few hundred feet of the site. The T-38 pilots informed us that they were turning up much shorter than the NOISEMAP tracks but that was only because the airplane performed better in the cool weather that we had at Laughlin during our measurement time frame. According to the pilots, in the summer months the aircraft will turn over the measurement location. So therefore, here is a case where the measurement was of a different event than what NOISEMAP predicted and NOISECHECK showed this clearly. It also shows that in all likelihood the measurement did not represent the long term average of total noise exposure at that site.

At Site 2 the closed loop pattern of the T-38 sound exposure levels seem to agree very well. Note: The NOISEMAP levels presented here does not take into account the NOISEMAP turn algorithm which would decrease the NOISEMAP predicted values for the closed loop pattern at this location. The slant distances from the photographs at this site are less than the NOISEMAP slant distances. This would seem to indicate that the T-38s were turning further out than the NOISEMAP ground track contradicting what we saw while at Site 3. But this can be explained because while we were at Site 2 we did not photograph all of the T-38 closed loop patterns but only those that came near us biasing us to the shorter slant distance. The measured SEL values for the other two patterns, T-38 departure and crosswind, are definitely less than the NOISEMAP values. The only thing that could account for this would be a power cutback by the aircraft before reaching this measurement location. Even if we adjust the NOISEMAP values for the slant distances we measured (depart would be 102.7 and crosswind would be 100.2), we still measured values around 6 dB less than predicted. A power cutback would have been possible due to the better aircraft performance during our measurement period. (See comments on Site 3.) A power cutback to the normal throttle back position would be around 95%-96% RPM. This would mean a noise level reduction of about 7-9 dB. Again, this explains that NOISEMAP was looking at a different situation than was measured. Yet if the pilots had not done a power cutback (as we suspect they did) before our measurement points, the noise levels for those two operations (depart and crosswind) would have brought the measurements more in line with the long term average exposure predicted by NOISEMAP.

At Laughlin AFB the average temperature and relative humidity for the measurement period when there were aircraft operations was 81°F and 60% relative humidity. To normalize the noise data (SELs) to the standard day weather (59°F and 70% relative humidity) that is used by NOISEMAP would result in corrections to the measured SELs of less than 0.1 dB. Therefore, no corrections were made to the measured data to normalize to the standard day weather conditions.

Measurement Program________Sheet __ of __

Site Number ______2______

Engineer ______Robert Lee______

Date ____________________

From Worksheet 8							Calculated			
Aircraft	Operation	Flt Trk	Aircraft SEL	Day Operations	Night Operations		Effective Numbers of Operations	Partial DNL	Rank Number	Total DNL Through Rank
T-38	Depart	13CA	100.3	110.1	2.7	Use Equations in Supplement	137.1	72.3	1	72.3
T-38	Depart	13CG	100.6	41.8	0		41.8	67.4	2	73.5
T-38	Cross-wind	13LD2	103.8	15.5	0		15.5	66.3	3	74.3
T-38	Cross-wind	13LD1	101.3	10.2	.6		16.2	64.0	4	74.7
T-38	Cross-wind	13LH	102.5	11.7	0		11.7	63.8	5	75.0
T-38	Cross-wind	13LE1	102.3	10.1	.2		12.1	63.7	6	75.3
T-38	Cross-wind	13CE	104.2	7.6	0		7.6	63.6	7	75.6
T-38	Closed	13LD3	91.7	21.3	4.0		61.3	60.2	8	75.7
T-38	Closed	13LE2	72.7	22.9	1.2		34.9	58.7	9	75.8
T-37	Depart 10°	13RA	85.1	84.7	1.7		101.7	55.8	10	75.8
T-38	Landing	31RF1	90.3	17.6	.9		26.6	55.1	11	75.9
T-38	Landing	31RD	88.9	11.9	1.1		22.9	53.1	12	75.9
T-38	Landing	31RF2	92.0	7.6	0		7.6	51.4	13	75.9

FIG. 4a. Worksheet 9 for Site 2 at Laughlin AFB TX

Measurement Program	Sheet __ of __
Site Number	3
Engineer	Robert Lee
Date	

From Worksheet 8							Calculated			
Aircraft	Operation	Flt Trk	Aircraft SEL	Day Operations	Night Operations		Effective Numbers of Operations	Partial DNL	Rank Number	Total DNL Through Rank
T-38	Closed	13LD3	109.4	21.3	4.0		61.3	77.9	1	77.9
T-38	Closed	13LE2	110.2	22.9	1.2	Use Equations in Supplement	34.9	76.2	2	80.1
T-38	Cross-wind	13LD2	110.3	15.5	0		15.5	72.8	3	80.9
T-38	Depart	13CA	100.3	110.1	2.7		137.1	72.3	4	81.4
T-38	Cross-wind	13LD1	109.4	10.2	.6		16.2	72.1	5	81.9
T-38	Cross-wind	13LE1	108.6	10.1	.2		12.1	70.0	6	82.2
T-38	Cross-wind	13LH	108.6	11.7	0		11.7	69.9	7	82.4
T-38	Depart	13CG	102.3	41.8	0		41.8	69.1	8	82.6
T-38	Cross-wind	13CE	102.6	7.6	0		7.6	62.0	9	82.7
T-37	Depart 10°	13RA	87.8	84.7	1.7		101.7	58.5	10	82.7
T-37	Closed	13RD1	88.2	61.0	1.2		73.0	57.4	11	82.7
T-38	Landing	31RF	91.0	25.2	.9		34.2	56.9	12	82.7
T-38	Landing	31RD	89.4	11.9	1.1		22.9	53.6	13	82.7
T-37	Landing	31LF	86.6	26.4	1.4		40.4	53.3	14	82.7
T-37	Closed	13RD2	89.0	8.8	0		8.8	49.0	15	82.7

FIG. 4b. Worksheet 9 for Site 3 at Laughlin AFB TX

Measurement Program ________ Sheet __ of __

Site Number 4

Engineer Robert Lee

Date ________

From Worksheet 8						Calculated			
Aircraft	Operation	Flt Trk	Aircraft SEL	Day Operations	Night Operations	Effective Numbers of Operations	Partial DNL	Rank Number	Total DNL Through Rank
T-38	Depart	13CA	106.8	110.1	2.7	137.1	78.8	1	78.8
T-38	Depart	13CG	105.5	41.8	0	41.8	72.3	2	79.7
T-38	Cross-wind	13LD2	105.0	15.5	0	15.5	67.5	3	79.9
T-38	Cross-wind	13LD1	104.5	10.2	.6	16.2	67.2	4	80.2
T-38	Cross-wind	13CE	107.8	7.6	0	7.6	67.2	5	80.4
T-38	Closed	13LD3	96.8	21.3	4.0	61.3	75.3	6	80.5
T-38	Cross-wind	13LE1	103.6	10.1	.2	12.1	65.0	7	80.6
T-38	Cross-wind	13LH	103.6	11.7	0	11.7	64.9	8	80.7
T-38	Closed	13LE2	97.8	22.9	1.2	34.9	63.8	9	80.8
T-37	Depart 10°	13RA	91.9	84.7	1.7	101.7	62.6	10	80.9
T-38	Landing	31CG	97.0	10.4	0	10.4	57.8	11	80.9
T-38	Landing	31CB2	94.7	9.5	.3	12.5	56.3	12	80.9
T-37	Closed	13RD1	86.2	61.0	1.2	73.0	55.4	13	80.9
T-37	Landing	31LF1	89.0	23.5	1.4	37.5	55.3	14	81.0
T-37	Landing	31LF2	96.5	2.9	0	2.9	51.7	15	81.0
T-38	Landing	31RF	85.7	25.2	.9	34.2	51.6	16	81.0
T-38	Landing	31RD	84.1	11.8	1.1	22.9	48.3	17	81.0
T-37	Closed	13RD2	87.1	8.8	0	8.8	47.1	18	81.0

Use Equations in Supplement

FIG. 4c. Worksheet 9 for Site 4 at Laughlin AFB TX

Date	Daily Dominant Ops Site 2	Site 3	Site 4	Adjustment to Ave Busy Day Ops Site 2	Site 3	Site 4
Feb 14	182	449	139	1.2	-1.2	2.2
Feb 15	61	244	31	6.0	1.4	8.7
Feb 16	Land Operations					
Feb 17	Saturday					
Feb 18	Sunday					
Feb 19	Holiday					
Feb 20	127	169	120	2.8	3.0	2.8
Feb 21	135	248	131	2.5	1.3	2.4
Feb 22	221	832	122	.4	-3.9	2.7
Feb 23	Landing Day					
Feb 24	Saturday					
Feb 25	Sunday					
Feb 26	283	713	213	- .7	-3.2	.3
Feb 27	320	723	254	-1.2	-3.3	- .5
Feb 28	Landing Day					
Mar 1	389	654	346	-2.1	-2.9	-1.8
Mar 2	121	238	102	3.0	1.5	3.5

Effective number of operations for NOISEMAP

Site 2 Flt tracks 13CA, 13CG, 13CE, 13LE1, 13LD1, 13LD2, 13LH = 242
(T-38 Departures & Crosswind Patterns)
(T-38 Center Runway + 14% Left Runway)

Site 3 13CA, 13CG, 13CE, 13LE, 13LD, 13LH = 338
(All T-38 Takeoff Activity)

Site 4 Flight Tracks 13CA, 13CE, 13CG = 228
(T-38 Center Runway Activity)

Figure 5. Adjustment for Measurement DNL to Average Busy Day Operations for Laughlin AFB TX

Measurement Program_____ Sheet ___ of___

Site Number 2

Engineer Robert Lee

Date

Date	Day of Week	From Paper Tape: Day No.	From Paper Tape: Meas. DNL	Bkgrnd. DNL (1)	DNL' (2)	Effective No. of Oper. (3)	No. Adj. (4)	Adj. DNL
Feb 14	Wed							
Feb 15	Thur		67.7	40	67.7	61	6.0	73.7
Feb 16	Fri		64.9	40	64.9	Landing Operation	NA	NA
Feb 17	Sat		38.9					
Feb 18	Sun		47.9					
Feb 19	Holiday Mon		41.9					
Feb 20	Tue		70.8	40	70.8	127	2.8	73.6
Feb 21	Wed		71.1	40	71.1	135	2.5	73.6
Feb 22	Thur		EQUIPMENT					
Feb 23	Fri		MALFUNCTIONED					
Feb 24	Sat							
Feb 25	Sun							
Feb 26	Mon							
Feb 27	Tue							
Feb 28	Wed							
Mar 1 Mar 2	Thur Fri							

(1) From Eq. 1 or Other Information

(2) From Eq. 2

(3) From Tower Log Analysis

(4) Adjustment $= -10 \log \dfrac{\text{Effective No. of Oper.}}{\text{NOISEMAP Effective No. of Oper.}}$

Calculated: Measurement Std. Deviation	Calculated: Measurement DNL
308,080	73.6

90% CI = 73.7 to 73.6

FIG. 6a. Worksheet 1 for Site 2 at Laughlin AFB TX

Measurement Program_____ Sheet___ of___

Site Number 3
Engineer Robert Lee
Date

Date	Day of Week	From Paper Tape: Day No.	From Paper Tape: Meas. DNL	Bkgrnd. DNL (1)	DNL' (2)	Effective No. of Oper. (3)	No. Adj. (4)	Adj. DNL
Feb 14	Wed							
Feb 15	Thur		77.7	45	77.7	244	1.4	79.1
Feb 16	Fri		74.5	45	74.5	NA	Landing Operation	
Feb 17	Sat		53.6					
Feb 18	Sun		52.7					
Feb 19	Holiday Mon		54.9					
Feb 20	Tue		73.3	45	73.3	169	3.0	76.3
Feb 21	Wed		77.2	45	77.2	248	1.3	78.5
Feb 22	Thur		77.0	45	77.0	832	- 3.9	73.1
Feb 23	Fri		76.9	45	76.9	NA	Landing Operation	
Feb 24	Sat		68.4					
Feb 25	Sun		64.2					
Feb 26	Mon		78.4	45	78.4	713	- 3.2	75.2
Feb 27	Tue		80.9	45	80.9	723	- 3.3	77.6
Feb 28	Wed		76.4	45	76.4	NA	Landing Operation	
Mar 1	Thur		78.1	45	78.1	654	- 2.9	75.2
Mar 2	Fri		75.1	45	75.1	238	1.5	76.6

(1) From Eq. 1 or Other Information

(2) From Eq. 2

(3) From Tower Log Analysis

(4) Adjustment $= -10 \log \dfrac{\text{Effective No. of Oper.}}{\text{NOISEMAP Effective No. of Oper.}}$

Calculated: Measurement Std. Deviation	Calculated: Measurement DNL
20,550,352	76.8

90% CI = 77.8 to 75.6

FIG. 6b. Worksheet 1 for Site 3 at Laughlin AFB TX

Measurement Program_____ Sheet ___ of ___

Site Number	4
Engineer	Robert Lee
Date	

Date	Day of Week	From Paper Tape		Bkgrnd. DNL (1)	DNL' (2)	Effective No. of Oper. (3)	No. Adj. (4)	Adj. DNL
		Day No.	Meas. DNL					
Feb 14	Wed		80.2	45	80.2	139	2.2	82.4
Feb 15	Thur		79.1	45	79.1	31 (81 Landings)	Infl by Landing Ops - NA	
Feb 16	Fri		74.2	45	74.2	Landing Operation	NA	
Feb 17	Sat		43.4					
Feb 18	Sun		57.7	45				
Feb 19	Holiday Mon		63.3					
Feb 20	Tue		77.4	45	77.4	120	2.8	80.2
Feb 21	Wed		78.3	45	78.3	131	2.4	80.7
Feb 22	Thur		78.0	45	78.0	122	2.7	80.7
Feb 23	Fri		77.5	45	77.5	Landing Operations	NA	
Feb 24	Sat		70.5					
Feb 25	Sun		68.9					
Feb 26	Mon		78.7	45	78.7	213	.3	79.0
Feb 27	Tue		81.1	45	81.1	254	- .5	80.6
Feb 28	Wed		77.5	45	77.5	Landing Operations	NA	
Mar 1	Thur		78.3	45	78.3	346	1.8	80.1
Mar 2	Fri		76.5	45	76.5	102	3.5	80.0

(1) From Eq. 1 or Other Information

(2) From Eq. 2

(3) From Tower Log Analysis

(4) Adjustment = $-10 \log \frac{\text{Effective No. of Oper.}}{\text{NOISEMAP Effective No. of Oper.}}$

Calculated	
Measurement Std. Deviation	Measurement DNL
27,285,659	80.6

90% CI = 81.2 to 80.0

FIG. 6c. Worksheet 1 for Site 4 at Laughlin AFB TX

Measurement Program ____ Sheet ___ of ___

Site Number 2

Engineer Robert Lee

Date

From Worksheet 9							From Chart Fig. 11	From Equation 1
Aircraft	Runway	Operation	Slant Distance	Elevation Angle	Aircraft SEL	Effective No. of Oper.	Variance	σ_i
T-38	13CA	Depart	1635'	37.3°	100.3	137.1	1	3.80×10^{11}
T-38	13CG	Depart	2029'	50.2°	100.6	41.8	3	2.34×10^{11}
T-38	13LD2	Cross-wind	1495'	33.3°	103.8	15.5	3	1.82×10^{11}
T-38	13LD1	Cross-wind	1866'	31.0°	101.3	16.2	3	1.07×10^{11}
T-38	13LH	Cross-wind	1557'	45.1°	102.5	11.7	1	5.39×10^{10}
T-38	13LE1	Cross-wind	1570'	45.5°	102.3	12.1	1	5.32×10^{10}
T-38	13CE	Cross-wind	1268'	66.8°	104.2	7.6	1	5.18×10^{10}
T-38	13LD3	Closed	4350'	12.3°	91.7	61.3	8	8.32×10^{10}
T-38	13LE2	Closed	3863'	13.9°	92.7	34.9	8	5.97×10^{10}

NOISEMAP DNL 75.9

Calculated σ 5,942,050

90% c.i. (+) 76.3

90% c.i. (-) 75.5

FIG. 7a. Worksheet 5 for Site 2 at Laughlin AFB TX

Measurement Program ____ Sheet ___ of ___

Site Number: 3

Engineer: Robert Lee

Date: ____

From Worksheet 9							From Chart Fig. 11	From Equation 1
Aircraft	Runway	Operation	Slant Distance	Elevation Angle	Aircraft SEL	Effective No. of Oper.	Variance	σ_i
T-38	13LD3	Closed	803'	75.7°	109.4	61.3	1	1.38×10^{12}
T-38	13LE2	Closed	713'	82.0°	110.2	34.9	1	9.46×10^{11}
T-38	13LD2	Cross-wind	748'	48.0°	110.3	15.5	1	4.30×10^{11}
T-38	13CA	Depart	1628'	22.9°	100.3	137.1	5	9.89×10^{11}
T-38	13LD1	Cross-wind	821'	52.5°	109.4	16.2	1	3.65×10^{11}
T-38	13LE1	Cross-wind	865'	54.7°	108.6	12.1	1	2.27×10^{11}
T-38	13LH	Cross-wind	865'	54.7°	108.6	11.7	1	2.19×10^{11}
T-38	13CG	Depart	1793'	33.3°	102.3	41.8	3	3.48×10^{11}
T-38	13CE	Cross-wind	1657'	25.2°	102.6	7.6	3	6.78×10^{10}

NOISEMAP DNL	82.7
Calculated σ	24,080,790
90% c.i. (+)	83.0
90% c.i. (-)	82.4

FIG. 7b. Worksheet 5 for Site 3 at Laughlin AFB TX

Measurement Program ____ Sheet ___ of ___

Site Number	4
Engineer	Robert Lee
Date	

From Worksheet 9							From Chart Fig. 11	From Equation 1
Aircraft	Runway	Operation	Slant Distance	Elevation Angle	Aircraft SEL	Effective No. of Oper.	Variance	σ_i
T-38	13CA	Depart	797'	90°	106.8	137.1	1	1.70×10^{12}
T-38	13CG	Depart	1246'	90°	105.5	41.8	1	3.84×10^{11}
T-38	13LD2	Cross-wind	1308'	32.8°	105.0	15.5	3	2.40×10^{11}
T-38	13LD1	Cross-wind	1378'	37.0°	104.5	16.2	1	1.18×10^{11}
T-38	13CE	Cross-wind	905'	84.0°	107.8	7.6	1	1.19×10^{11}
T-38	13LD3	Closed	2832'	17.6°	96.8	61.3	5	1.98×10^{11}
T-38	13LE1	Cross-wind	1421'	39.3°	103.6	12.1	1	7.18×10^{10}
T-38	13LH	Cross-wind	1421'	39.3°	103.6	11.7	1	6.94×10^{10}
T-38	13LE2	Closed	2527'	18.3°	97.8	34.9	5	1.42×10^{11}

NOISEMAP DNL	81.0
Calculated σ	31,734,775
90% c.i. (+)	81.6
90% c.i. (-)	80.4

FIG. 7c. Worksheet 5 for Site 4 at Laughlin AFB TX

Measurement Program ____ Sheet ____ of ____

File Number: 2

Engineer: Robert Lee

Date:

From Worksheet	or Worksheet	From Worksheet	From NOISEMAP
Measurement Standard Deviation	Measurement DNL	NOISEMAP Standard Deviation	NOISEMAP DNL
σ_S or $\underline{\sigma_M}$	$\underline{\text{DNL(M)}}$ or DNL(S)	σ_i	DNL(C)
308,080	73.6	5,942,050	75.9

Calculated
Parameter Z
2.69

↓

From Table 1
Parameter p
.9964

↓

Calculated
Probability Equals 2 - 2p
.0072

This Value is the Probability that the Measurements and the NOISEMAP Predictions are Consistent.

(The Probability that they are not Consistent is 1 Minus this Value.)

FIG. 8a. Worksheet 6 for Site 2 at Laughlin AFB TX

Measurement Program____ Sheet___ of___

File Number	3
Engineer	Robert Lee
Date	

From Worksheet	or Worksheet	From Worksheet	From NOISEMAP
Measurement Standard Deviation	Measurement DNL	NOISEMAP Standard Deviation	NOISEMAP DNL
σ_S or σ_M	DNL(M) or DNL(S)	σ_i	DNL(C)
20,550,352	76.8	24,080,790	82.7

Calculated
Parameter Z
4.37

↓

From Table 1
Parameter p
.9999

↓

Calculated
Probability Equals 2 - 2p
.0002

This Value is the Probability that the Measurements and the NOISEMAP Predictions are Consistent.

(The Probability that they are not Consistent is 1 Minus this Value.)

FIG. 8b. Worksheet 6 for Site 3 at Laughlin AFB TX

Measurement Program____ Sheet___ of___

File Number 4

Engineer Robert Lee

Date

From Worksheet	or Worksheet	From Worksheet	From NOISEMAP
Measurement Standard Deviation	Measurement DNL	NOISEMAP Standard Deviation	NOISEMAP DNL
σ_S or $\underline{\sigma_M}$	$\underline{DNL(M)}$ or DNL(S)	σ_i	DNL(C)
27,285,659	80.6	31,734,775	81.0

Calculated
Parameter Z
0.26

↓

From Table 1
Parameter p
.6026

↓

Calculated
Probability Equals 2 - 2p
.7948

This Value is the Probability that the Measurements and the NOISEMAP Predictions are Consistent.

(The Probability that they are not Consistent is 1 Minus this Value.)

FIG. 8c. Worksheet 6 for Site 4 at Laughlin AFB TX

TABLE 1

REGROUPED RANK ORDERED LDN MAIN CONTRIBUTORS
AT LAUGHLIN AFB TX

SITE	AIRCRAFT	FLIGHT TRANS	OPERATION	SEL	AV SLANT DISTANCE	EFFECTIVE OPS	PART DNL	RANK #	TOTAL DNL THROUGH RANK
2	T-38	13CA1 13CAL 13CA3 13CG	Depart	100.4	1750'	178.9	73.5	1	73.5
	T-38	13LD1 13LD2 13LH 13LE1 13CE	Crosswind	103.0	1550'	63.1	71.6	2	75.7
	T-38	13LD3 13LE2	Closed Loop	92.2	4100'	96.2	62.6	3	75.9
3	T-38	13LD3 13LE2	Closed Loop	109.8	760'	96.2	80.2	1	80.2
	T-38	13LD2 13LD1 13LE1 13LH	Crosswind Left Runway	109.3	825'	55.5	77.3	2	82.0
	T-38	13CA1 13CA2 13CA3 13CG	Depart	100.9	1670'	178.9	74.0	3	82.6
4	T-38	13CA1 13CA2 13CA3 13CG	Depart	106.5	900'	178.9	79.6	1	79.6
	T-38	13LD1 13LD2 13LH 13LE1	Crosswind Left Runway	104.2	1380'	55.5	72.2	2	80.3
	T-38	13LD3 13LE2	Closed Loop	97.3	2680'	96.2	67.7	3	80.6
	T-38	13CE	Crosswind Center Runway	107.8	905'	7.6	67.2	4	80.7

TABLE 2

MEASURED SELs AND ALTITUDES
AT LAUGHLIN AFB TX

SITE	AIRCRAFT	OPERATION	SEL MEASURED	#	SLANT DISTANCE AVE PHOTOS	#	NOISEMAP SEL	NOISEMAP SLANT DIST
	T-38	Depart	96.0	13	1368'	5	100.4	1750'
2	T-38	Crosswind	95.1	4	2025'	5	103.0	1550'
	T-38	Closed Loop	90.5	22	3620'	13	92.2	4100'
	T-38	Closed Loop	105.1	1	--	--	109.8	760'
3	T-38	Crosswind Left Runway	95.2	1	--	--	109.3	825'
	T-38	Depart	98.8	8	--	--	100.9	1670'
	T-38	Depart	108.2	21	638'	1	106.5	900'
4	T-38	Crosswind Left Runway	102.9	4	1965'	2	104.2	1380'
	T-38	Closed Loop	98.8	18	--	--	97.3	2600'
	T-38	Crosswind Center Runway	No Data	--	--	--	107.8	905'

IV. HOMESTEAD AFB STUDY

TEST PREPARATION

After the problems encountered at Laughlin AFB a less ambitious test was planned for Homestead AFB. Under the approach flight tracks at Homestead AFB was a PUD (Planned Urban Development) area that has area within the DNL 65 to 80 contours. See Figure 9. The purpose of this test is to help document the noise exposure for prevention against future encroachment. For this test a monitor was to be placed on either side of the PUD area directly under the flight tracks. The third monitor was to be placed in the middle of a highly suspect "bulge" in the contours located near a ground runup trim pad. This area was suspect because of the large amount of high power (military and afterburner) run time on trim pads 10 and 11 (the trim pads near the bulge).

Figure 10 shows the dominant input flight tracks and the measurement locations at Homestead AFB FL. All three monitors were to be left at the same locations for the duration of the test (2 weeks) to obtain a good statistical sampling of the daily DNL values (about 8-10 busy day DNLs can be obtained in a two week measurement).

Mr. Roland Allen in the Civil Engineering Office at Homestead was identified as our point of contact. A detailed test plan, AMRL/BBE-TP-32, was sent to him for coordination/information of the various base organizations that we would require support from, i.e., Base Commander, Director of Maintenance, Base Operations, etc. To help expedite getting the monitors out to start data collection, Mr. Allen went out and surveyed the area for specific sites to place our monitors and obtained permission to take measurements prior to the start of the test. This saved us several days of valuable data collection time. Also coordination was made with Base Operations to collect the traffic count on each flight track using their designation for each flight track. See Figure 2B. The tracks are identified as follows: VI is vector to intercept approach, PA is precision approach, SA is surveillance approach and TA is a TACAN approach. Other approaches that were used followed these basic tracks and are as follows: PSG is a precision shotgun approach and is used for two or three aircraft that come in on the SA track, ILS and ARA are an instrumented landing approach and airborne radar approach and follow the PA track and the VA is a visual approach that somewhat uses the VI track but does an overhead pass, pitch out and then lands. This left only the touch and go patterns and the pitch outs that were not being counted by Base Operations.

It was felt we could screen the events from Site 2 to Site 1 and attribute these events to the touch and go patterns so no attempt was made to task Base Operations with the added job of counting these events.

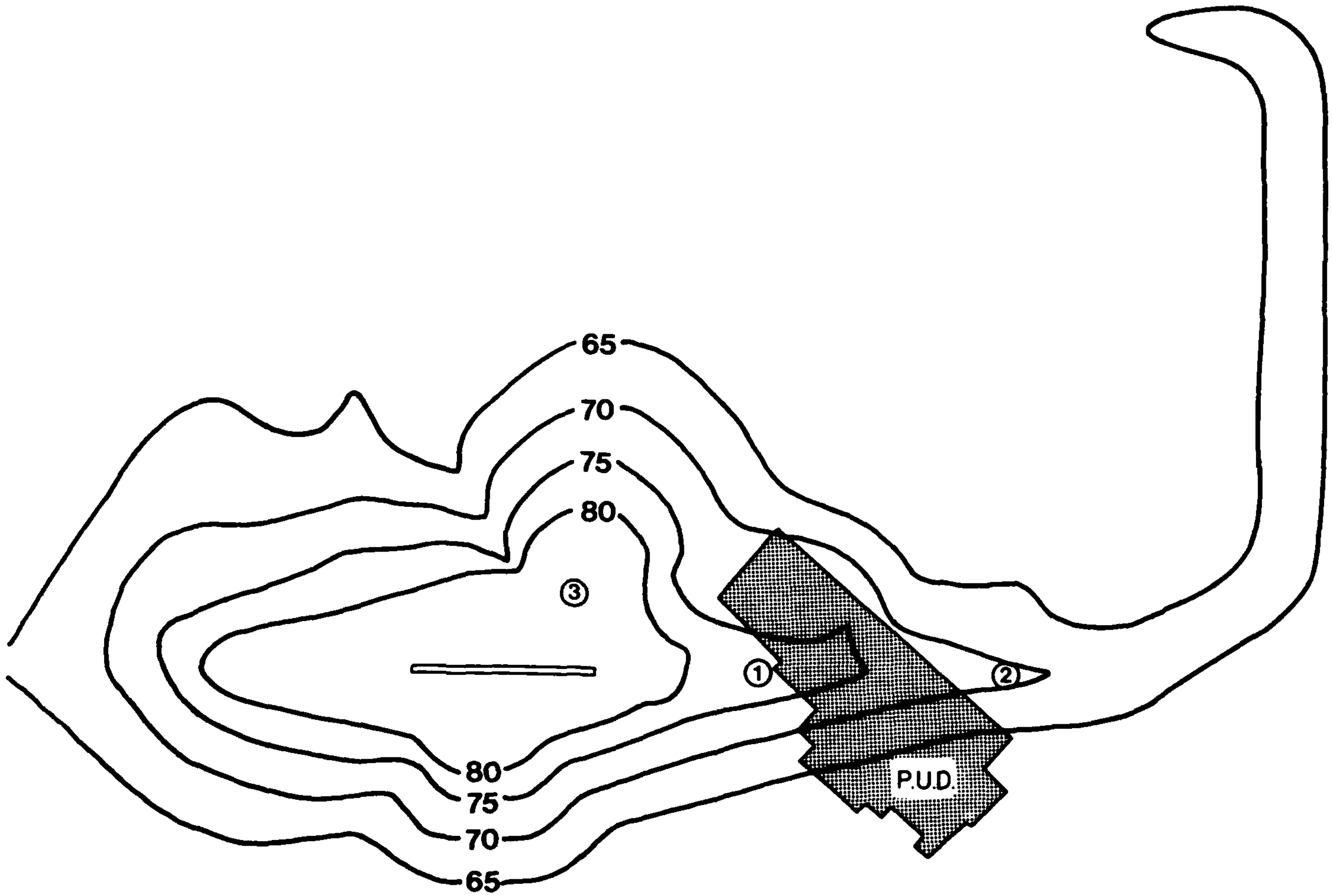


Figure 9. Planned Urban Development (PUD) and NOISECHECK Measurement Locations at Homestead AFB FL

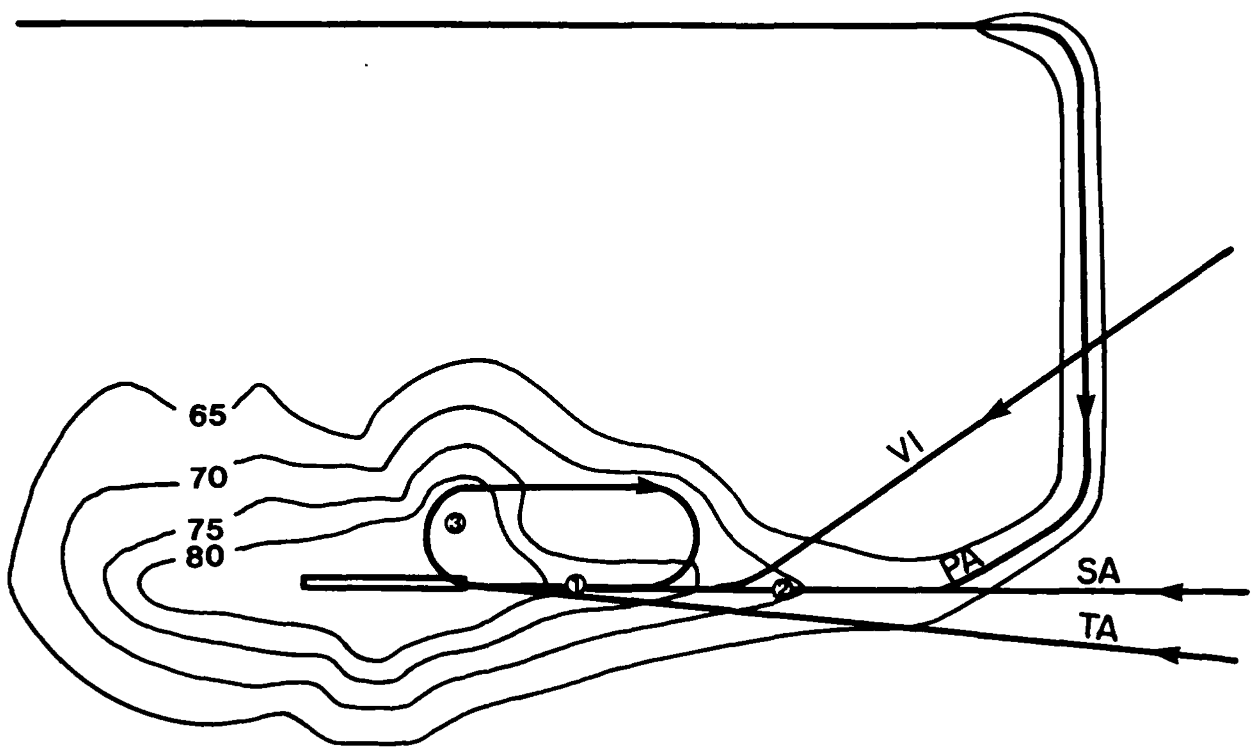


Figure 10. Dominant Flight Tracks at Homestead AFB FL

DATA COLLECTION AT HOMESTEAD AFB

Initial Setup

Things went relatively smoother at Homestead AFB. Our point of contact, Mr. Roland Allen, had previously scouted the proposed measurement locations and obtained permission for us to place our systems out at almost the exact locations in the proposed plan. This allowed us to get monitors up and running at locations 1 and 2, Monday, September 10th, the first day of our test period. The next day when servicing the monitors, the monitor at Site 1 malfunctioned with a complete power loss when the unit was opened. We replaced this monitor with the monitor for Site 3 and brought the malfunctioning unit back to the base. The power loss occurred because the clips from the battery to the disconnect point had fallen off. This was corrected by soldering the clips on to the battery terminals for this and the other units battery packs. (We recommend for anyone using the NOISECHECK units to solder these clips.) On September 13 we placed the third unit at Location 3. All the units were chained down with a chain wrapped around the case through the handle and locked to a tree or some other solid stanchion. Extra precaution was taken by placing the units behind brush and out of sight. But even so, the unit at Location 3 was stolen on September 18th and therefore no conclusive data is presented for the actual levels for the runup bulge area.

Collection of Acoustic and Weather Data

The NOISECHECK units were set to printout hourly noise levels (HNL), community noise levels (CNEL), day-night levels (DNL), and sound exposure levels (SEL) for the complete duration of the test. SELs were taken for the complete duration of the test at Homestead because all of the landing operations except pitchout maneuvers were being logged by Base Operations. With this information virtually every noise event that occurred at the monitors was identified. Table B-1 lists the HNLs, DNLs and CNELs collected from the monitors. Table B-2 lists the temperature and relative humidity during the test collected by Base Weather. The blocked-in area indicates when there was aircraft activity.

Collection of Aircraft Operations Information at Homestead AFB

The collection of aircraft operations was simpler at Homestead AF Base because most of the aircraft activity over our measurement positions was already being logged by Base Operations. Only two kinds of operations that occurred near our measurement locations, the pitchout landing and the November-Kilo takeoff, were not logged by Base Operations. To do a pitchout landing a plane coming in on a normal approach would veer to the right after passing the end of the runway and fly a complete race track before landing. Base Operations would log this as one normal approach even though the aircraft ground track would pass over Location 1 twice. November-Kilo was a code for a takeoff scramble to the south. The aircraft would be low and at max power over Location 1 but high or veered to either side of Location 2. Since this occurred at random times on an alert or practice alert basis, it is not certain exactly how many occurred during our measurement period. These two unlogged events could have had an impact on the field measured DNL at Site 1 but probably had no impact at Site 2. Table B-3 lists the operations that were logged by Base Operations and the NOISEMAP flight tracks associated with each. Every one of these events were identified with a specific noise event recorded by our NOISECHECK units. Also included in this table is a comparison of the logged busy day operations with the NOISEMAP busy day operations by flight track.

Engine power setting, airspeed and aircraft altitude at the microphone locations were obtained by talking to the standard evaluation personnel at Homestead. Table B-4 lists the F-4 values for a standard approach which was flown on all the approach flight tracks. The T-38s were considered and measured as inconsequential to the total noise exposure metric DNL. Photographs were taken from the microphone locations with the aircraft at the point of closest approach to verify the slant distance to the aircraft. Table B-5 gives the summary from photographic scaling.

Determination of which aircraft/flight tracks that were significant at each location proved to be a very time consuming job even with the small number of aircraft/flight tracks that were at Homestead. This could be easily done by the NOISEMAP program itself and would provide the screening technique that is needed for determining the amount of operational data that is required at each location.

DATA ANALYSIS AT HOMESTEAD AFB

1. Direct Measurement DNL Analysis

To determine how much individual operations influence each measurement point we need to determine the major DNL contributors at those measurement points. At Homestead AFB, since the monitor at location three was stolen halfway through the survey, we will only look at the data for the two locations on either side of the PUD (Proposed Urban Development) area. The list of DNL contributors for each measurement location (Worksheet 9 from the NOISECHECK procedures) are presented in Figures 11a and 11b. The flight track descriptor tells what runway was used. Runway 05 is a landing over the measurement points and Runway 23 is a takeoff over the measurement points. From these worksheets we can see that on an average busy day these sites are not significantly affected by any of the T-38 operations or the F-4 takeoff operations with the possible exception of the straight out takeoffs on 23A. Site 1 is dominated by the four F-4 landing operations; vector to intercept with pitchout, surveillance approach, precision approach and touch-and-go pattern.

Site 2 is dominated by the F-4 precision approach and the surveillance approach. Figure 12 shows the effective number of dominant operations for an average busy day from the NOISEMAP inputs, the daily number of dominant operations from the tower count and the adjustment to be applied to the measured daily DNLs for each site. These adjustments are now input into the Worksheet 1s for each site (see Figures 13a and 13b). This worksheet then gives us the measurement DNL, the associated standard deviation and the 90% confidence intervals at each site. To compare these values with NOISEMAP we need to determine the NOISEMAP DNL, standard deviation and the 90% confidence intervals at each measurement location. Worksheets 14a and 14b give these values. Next we need to calculate the probability that the measured DNL and the NOISEMAP calculated DNL are consistent. Figures 15a and 15b (Worksheet 6s) give the probabilities for each location. The final results are summarized in the following table:

Homestead AFB Measurement Sites	Measurement DNL DNL(M)	NOISEMAP DNL DNL(C)	Probability of Consistency
1	77.6	79.6	.1646
2	70.4	69.5	.6950

This analysis tells us that there is very good agreement at Site 2 and a minimal agreement at Site 1. Yet at Site 1 there are close 90% confidence intervals around both the NOISEMAP and measurement values suggesting that some factor was skewing the results like a possible power setting cutback over this measurement point. Again, to find out the cause of this problem, we need a more detailed analysis using the SEL information collected by NOISECHECK.

2. Calculated DNL From Measured SEL Analysis At Homestead AFB, FL

The first step in synthesizing the DNL values from the SEL is to identify the operations that produced each individual SEL. At Homestead AFB, Base Operations kept track of every operation that occurred. By correlating the times from the aircraft logs with the times of events on the NOISECHECK units, the SELs for all the logged aircraft activity were identified. Figure 16 gives an example from the Sept 14 logs of this correlation. Next, we take these measured SELs and add them up on the next worksheet. Figures 17a and 17b show the completed Worksheet 3s for each measurement site. Now following the same procedures used in the measured DNL analyses, we add all the operations to obtain the DNL at each site and its 90% confidence interval (Figures 18a and 18b) and the probability of consistency with the NOISEMAP predicted values (Figures 19a and 19b). The following table shows the final results.

Homestead AFB Measurement Sites	Synthesized DNL DNL(S)	NOISEMAP DNL DNL(C)	Probability of Consistency
1	73.9	79.6	.0050
2	67.5	69.5	.5418

Although this SEL analysis has lowered the probability of consistency from the measured DNL analysis, we can now see what is causing the discrepancies. First looking at Site 1, NOISEMAP says the main contributors are flight tracks 05G1 (VI and Pitchout) and 05J1 (SA with a pitchout maneuver) with almost identical SEL of 109.7 and 109.5. The SELs for 05G1 are caused by the aircraft coming in on a normal landing glide slope then pitching out to the right before the end of the runway (after passing Site 1) then making a short loop and landing (passing over Site 1 again). Individually, this gives SEL values of 102.0 for the first pass and 108.9 for the second pass. While we were out at Site 1 we noticed that most of these pitchouts would circle well before Site 1, therefore never having a chance to add in the SEL of 108.9 expected by NOISEMAP to the total exposure measured in the field. Now the 05J1 (SA) approaches are slightly different. In NOISEMAP, they come over the Site 1 at a high altitude first, producing an SEL of 99.7 then pitching out and coming back over Site 1 at a lower altitude producing an SEL of 109.0. From our observations in the field, this maneuver was done as described in NOISEMAP. Another problem with the data at Site 1 was that for all the four landing operations NOISEMAP used the reference landing power setting in NOISEMAP of 87% RPM and 190 KTS. Standard evaluation personnel at Homestead said that the nominal power setting over Site 1 was 84% - 85% RPM and 160 knots. Using 84.5% as the average value these differences (airspeed and power setting) would cause NOISEMAP to overpredict the SEL values for all four landing operations by 1.7 dB. If we incorporate these two differences (short turn for VI and 84.5% RPM power at 160 knots) into the NOISEMAP program, it would produce a value of 74.9 LDN. Following through the rest of the equations on the worksheets, we get the following values:

Operation	SEL	Effective No. of Operations	Variance	i
VI	102.0	25.71	1	1.06×10^{11}
SA	107.8	18.38	1	2.87×10^{11}
PA	106.8	22.42	1	2.78×10^{11}
TA	103.3	4.43	3	4.64×10^{10}

This gives us a σ_c of 4.81×10^6 and a 90% confidence interval of 74.3 to 75.4. This then gives us values of Z = .295, P = .6160 and a probability of consistency of .7680. Also at Site 1 our measurements of slant distance to the aircraft (approximately 630 ft.) were consistently higher than the NOISEMAP slant distances (approximately 530 ft.). This would cause our measured SEL to be approximately 1.5 dB lower than the NOISEMAP prediction. Although this would bring the measurements and NOISEMAP values closer together, I did not include the larger slant distance in recomputing the NOISEMAP values. This was because standard evaluation personnel claimed that the average height over this measurement location was close to what was already input to NOISEMAP and not the 630 ft. that I measured.

At Site 2 we had fairly good agreement between measured and NOISEMAP values but the probability of consistency of .5418 reflects the 2 dB separation between the two values. But again looking at the main contributors at this site, we find one of the same problems. Here all the flight tracks were being flown as indicated in NOISEMAP but the power settings and airspeeds that were input to NOISEMAP were the reference 87% RPM and 190 KTS. Again, the standard evaluation personnel at Homestead AFB told us that over Site 2 the F-4, on approach, would be between 83% and 87% RPM and between 230 KTS and 160 KTS. Standard evaluations altitude again agreed with the NOISEMAP input and was within 8% of our measured value. If we incorporate this one difference (85.5% RPM and 195 KTS, the mean values from standard evaluation) into the NOISEMAP program, it would produce an LDN value of 67.9. Following through the rest of the equations on the worksheets, we get the following values:

Operation	SEL	Effective No. Of Operation	Variance	i
PA	102.0	22.42	1	9.20×10^{10}
SA	98.3	28.38	1	3.22×10^{10}
VI	91.8	25.71	8	3.57×10^{10}
TA	97.2	4.43	3	1.14×10^{10}

This gives us a σ_c of 1.21×10^6 and a 90% confidence interval of 67.2 to 68.6. This then gives us values of Z = .1035, P = .5412 and a probability of consistency of .9176. The following table summarizes the results of correcting these input errors to NOISEMAP.

Homestead AFB Measurement Sites	Synthesized DNL DNL(S)	NOISEMAP DNL DNL(C)	Probability of Consistency
1	73.9	74.9	.7680
2	67.5	67.9	.9176

At Homestead AFB the average temperature and relative humidity for the measurement period when there were aircraft operations was 83°F and 75% relative humidity. To normalize the measured SELs to the standard day weather (59°F and 70% relative humidity) used in NOISEMAP we have to add 0.5 dB to the SELs at Site 2 and 0.4 dB to the SELs at Site 1. These offsets carry straight through in the DNL computations to give us values of 74.3 DNL for Site 1 and 68.0 DNL for Site 2. Assuming the scatter in the data remained the same, the results of the weather adjustments are summarized in the following table.

HOMESTEAD AFB MEASUREMENT SITES	SYNTHESIZED DNL DNL(S)	NOISEMAP DNL DNL(C)	PROBABILITY OF CONSISTENCY
1	74.3	74.9	.8532
2	68.0	67.9	.9780

Measurement Program ______ Sheet __ of __

Site Number 1

Engineer Robert Lee

Date ______

Use Equations in Supplement

From Worksheet 8						Calculated			
Aircraft	Operation	Flt Trk	Aircraft SEL	Day Operations	Night Operations	Effective Numbers of Operations	Partial DNL	Rank Number	Total DNL Through Rank
F-4	VI & Pitchout	05G1	109.7*	25.71	0	25.71	74.41	1	74.4
F-4	SA	05J1	109.5*	18.38	0	18.38	72.73	2	76.7
F-4	PA	05E1	108.5	20.02	.24	22.42	72.61	3	78.1
F-4	T&G	05I1	109.0	19.88	0	19.88	72.58	4	79.2
F-4	T10	23A	111.9	1.53	.02	1.73	64.88	5	79.3
F-4	T10	23B	111.9	1.12	.01	1.22	63.36	6	79.4
F-4	TA	05F1	105.0	4.13	.03	4.43	62.06	7	79.5
F-4	T10	23C	111.9	.77	0	.77	61.36	8	79.6
T-38	PA	05E6	95.1	1.88	0	1.88	48.44	9	79.6
F-4		23I1	96.8	1.12	0	1.12	47.89	10	79.6
T-38	VI & Pitchout	05G4	95.8*	.55	0	.55	43.80	11	79.6
T-38	SA	05J4	95.8*	.26	0	.26	40.55	12	79.6
F-4		23J	87.9	1.14	0	1.14	39.07	13	79.6
T-38	TA	05F3	91.7	.32	0	.32	37.35	14	79.6
T-38		23C	94.1	.14	0	.14	36.16	15	79.6
T-38	T&G	05I3	85.5	.09	0	.09	25.64	16	79.6
T-38		23J	79.6	.03	0	.03	14.97	17	79.6

*Addition of SELs due to aircraft passing over site twice.

FIG. 11a. Step-by-step Estimation of the Relative Importance of Operations at Site 1 at Homestead AFB FL

Measurement Program ________ Sheet __ of __

Site Number: 2

Engineer: Robert Lee

Date: ________

From Worksheet 8							Calculated			
Aircraft	Operation	Flt Trk	Aircraft SEL	Day Operations	Night Operations		Effective Numbers of Operations	Partial DNL	Rank Number	Total DNL Through Rank
F-4	PA	05E1	103.5	20.02	.24		22.42	67.61	1	67.6
F-4	SA	05J1	99.8*	18.38	0	Use Equations in Supplement	10.38	63.04	2	68.9
F-4	VI & Pitchout	05G1	93.3*	25.71	0		25.71	58.00	3	69.3
F-4	TA	05F1	98.4	4.13	.03		4.43	55.46	4	69.4
F-4	T10	23A	98.8	1.53	.02		1.73	51.78	5	69.5
F-4	T&G	05I1	83.7	19.88	0		19.88	47.28	6	69.5
T-38	PA	05E6	90.2	1.88	0		1.88	43.54	7	69.5
F-4	T10	23B	87.2	1.12	.01		1.22	38.66	8	69.5
F-4	T10	23C	87.2	.77	0		.77	36.66	9	69.5
T-38	TA	05F3	85.3	.32	0		.32	30.95	10	69.5
F-4		23I1	76.7	1.12	0		1.12	27.79	11	69.5
T-38	SA	05J4	82.0*	.26	0		.26	26.75	12	69.5
T-38	VI & Pitchout	05G4	76.2*	.55	0		.55	24.20	13	69.5
F-4		23J	71.3	1.14	0		1.14	22.47	14	69.5
T-38		23C	75.1	.14	0		.14	17.16	15	69.5

*Addition of SELs due to aircraft passing over site twice.

FIG. 11b. Step-by-step Estimation of the Relative Importance of Operations at Site 2 at Homestead AFB FL

Date	Daily Dominant Ops Site 1	Site 2	Adjustment to Ave Busy Day Ops Site 1	Site 2
Sept 11	86	27	0	1.8
12	Takeoffs on this day		-	-
13	Takeoffs on this day		-	-
14	75	60	0.6	-1.7
15	Saturday		-	-
16	Sunday		-	-
17	49	39	2.5	0.2
18	64	38	1.3	0.2
19	79	57	0.4	-1.5
20	70	56	0.9	-1.4
21	65	46	1.2	-0.5

NOTE: ILS and PSG (Precision Shotgun) approaches were counted under precision approaches for both sites. Effective number of operations for NOISEMAP.

SITE 1 Flt Tracks 05G1, 05J1, 05E1 and 05I1 = 86.4

SITE 2 Flt Tracks 05E1 and 05J1 = 40.8

Fig. 12. Adjustment For Measurement DNL To Average Busy Day Operations at Homestead AFB FL

Measurement Program ____ Sheet ___ of ___

Site Number 1
Engineer Robert Lee
Date

Date	Day of Week	From Paper Tape: Day No.	From Paper Tape: Meas. DNL	Bkgrnd. DNL (1)	DNL' (2)	Effective No. of Oper. (3)	No. Adj. (4)	Adj. DNL
Sep 11	Tue		79.0	55	79.0	88	0	79.0
12	Wed		76.2[1]	55	76.2	Takeoff Operations		
13	Thur		75.7[1]	55	75.7	Takeoff Operations		
14	Fri		75.3	55	75.3	75	0.6	75.9
15	Sat		74.2	55				
16	Sun		65.9	55				
17	Mon		72.9	55	72.9	49	2.5	75.4
18	Tue		78.3	55	78.3	64	1.3	79.6
19	Wed		77.1	55	77.1	79	0.4	77.5
20	Thur		75.2	55	75.2	70	0.9	76.1
21	Fri		76.8	55	76.8	65	1.2	78.0
1 MISSING HNL WERE RECONSTRUCTED FROM Δ OF SITE 2								

(1) From Eq. 1 or Other Information

(2) From Eq. 2

(3) From Tower Log Analysis

(4) Adjustment = $-10 \log \frac{\text{Effective No. of Oper. NOISEMAP}}{\text{Effective No. of Oper.}}$

Calculated	
Measurement Std. Deviation	Measurement DNL
21,591,164	77.6

90% CI = 75.6 to 79.0

FIG 13a. Worksheet 1 for Site 1 at Homestead AFB FL

Measurement Program _____ Sheet ___ of ___

Site Number	2
Engineer	Robert Lee
Date	

Date	Day of Week	From Paper Tape Day No.	From Paper Tape Meas. DNL	Bkgrnd. DNL (1)	DNL' (2)	Effective No. of Oper. (3)	No. Adj. (4)	Adj. DNL
Sep 11	Tue		69.6	55	69.6	27	1.8	71.4
12	Wed		69.0	55	69.0	Takeoff Operations		
13	Thur		68.9	55	68.9	Takeoff Operations		
14	Fri		70.8	55	70.8	60	-1.7	69.1
15	Sat		67.0	55				
16	Sun		61.6	55				
17	Mon		70.7	55	70.7	39	0.2	70.9
18	Tue		71.9[2]	55	71.9	38	0.2	72.1
19	Wed		72.4	55	72.4	57	-1.5	70.9
20	Thur		69.7	55	69.7	56	-1.4	68.3
21	Fri		69.0	55	69.0	46	-0.5	68.5
2 CORRECTED FOR TRUCK IDLING BY MICROPHONE NEAR MIDNIGHT.								

(1) From Eq. 1 or Other Information

(2) From Eq. 2

(3) From Tower Log Analysis

(4) Adjustment $= -10 \log \frac{\text{Effective No. of Oper.}}{\text{NOISEMAP Effective No. of Oper.}}$

Calculated	
Measurement Std. Deviation	Measurement DNL
3,652,593	70.4

90% CI = 68.6 to 71.6

FIG. 13b. Worksheet 1 for Site 2 at Homestead AFB FL

WORKSHEET 5

CALCULATION OF THE NOISEMAP CONFIDENCE INTERVALS AND STANDARD DEVIATION

Measurement Program ____ Sheet ___ of ___

Site Number 1

Engineer Robert Lee

Date

From Worksheet 9							From Chart Fig. 7	From Equation 1
Aircraft	Runway	Operation	Slant Distance	Elevation Angle	Aircraft SEL	Effective No. of Oper.	Variance	σ_i
F-4	05G1	VI & Pitchout	499'	90°	109.7	25.71	1	6.20x10[11]
F-4	05J1	SA	493'	90°	109.5	18.38	1	4.24x10[11]
F-4	05E1	PA	536'	90°	108.5	22.42	1	4.11x10[11]
F-4	05I1	T&G	494'	90°	109.0	19.88	1	4.09x10[11]
F-4	23A	T10	1500'	90°	111.9	1.73	1	6.94x10[10]
F-4	23B	T10	1500'	90°	111.9	1.22	1	4.89x10[10]
F-4	05F1	TA	964'	28°	105.0	4.43	3	6.87x10[10]
F-4	23C	T10	1500'	90°	111.9	.77	1	3.09x10[10]

NOISEMAP DNL	79.6
Calculated σ	11,060,722
90% c.i. (+)	79.9
90% c.i. (-)	79.3

Fig. 14a. Worksheet 5 for Site 1 at Homestead AFB FL

WORKSHEET 5

CALCULATION OF THE NOISEMAP CONFIDENCE INTERVALS AND STANDARD DEVIATION

Measurement Program ____ Sheet ___ of ___

Site Number 2

Engineer Robert Lee

Date ______

From Worksheet 9							From Chart Fig. 7	From Equation 1
Aircraft	Runway	Operation	Slant Distance	Elevation Angle	Aircraft SEL	Effective No. of Oper.	Variance	σ_i
F-4	05E1	PA	1196'	90°	103.5	22.42	1	1.30×10^{11}
F-4	05J1	SA	2000'	90°	99.8	18.38	1	4.54×10^{10}
F-4	05G1	VI & Pitchout	4357'	32°	93.3	25.71	8	5.05×10^{10}
F-4	05F1	TA	2356'	27°	98.4	4.43	3	1.50×10^{10}
F-4	23A	T10	3465'	90°	98.8	1.73	5	8.84×10^{9}
F-4	05I1	T&G	9761'	7°	83.7	19.88	12	5.69×10^{9}

NOISEMAP DNL 69.5

Calculated σ 1,710,730

90% c.i. (+) 70.0

90% c.i. (-) 68.9

Fig. 14b. Worksheet 5 for Site 2 at Homestead AFB FL

WORKSHEET 6

Measurement Program____ Sheet___ of___

Site Number ______1______

Engineer ______Robert Lee______

Date ______________

From Worksheet 1 or Worksheet 4		From Worksheet 5	From NOISEMAP
Measurement Standard Deviation	Measurement DNL	NOISEMAP Standard Deviation	NOISEMAP DNL
σ_S or σ_M	DNL(M) or DNL(S)	σ_i	DNL(C)
3,652,593	70.4	1,710,730	69.5

Calculated
Parameter Z
.51

↓

From Table 1
Parameter p
.6950

↓

Calculated
Probability Equals 2 - 2p
.6100

This Value is the Probability that the Measurements and the NOISEMAP Predictions are Consistent.

(The Probability that they are not Consistent is 1 Minus this Value.)

Fig. 15a. Worksheet 6 for Site 1 at Homestead AFB FL

WORKSHEET 6

Measurement Program____ Sheet___ of____

Site Number	2
Engineer	Robert Lee
Date	

From Worksheet 1 or Worksheet 4		From Worksheet 5	From NOISEMAP
Measurement Standard Deviation	Measurement DNL	NOISEMAP Standard Deviation	NOISEMAP DNL
σ_S or σ_M	DNL(M) or DNL(S)	σ_i	DNL(C)
21,591,164	77.6	11,060,722	79.6

Calculated
Parameter Z
1.39

↓

From Table 1
Parameter p
.9177

↓

Calculated
Probability Equals 2 - 2p
.1646

This Value is the Probability that the Measurements and the NOISEMAP Predictions are Consistent.

(The Probability that they are not Consistent is 1 Minus this Value.)

Fig. 15b. Worksheet 6 for Site 2 at Homestead AFB FL

BASE OPERATIONS LOG		SITE 1			SITE 2		
Event	Time	Time	SEL	AL	Time	SEL	AL
1 C-130 PA	03:31	Not Recorded			Not Recorded		
1 F-4 TA	09:41	9:48:00	109.5	105.7	9:48:31	97.9	90.5
1 F-4 SA	09:58	9:57:07	107.3	102.2	9:57:36	105.2	100.0
1 F-4 SA	10:08	10:06:25	107.5	103.6	10:06:56	91.6	84.0
3 F-4 VI	10:08	10:08:24	101.2	94.8	10:09:18	100.8	94.1
1 F-4 PA	10:17	10:15:23	105.4	100.7	10:15:56	102.8	97.0
1 F-4 PA	10:25	10:24:18	107.6	103.3	10:24:52	103.4	94.6
1 F-4 PA	10:35	10:33:19	105.9	101.8	10:33:51	100.1	92.6
1 F-4 PA	10:37	10:42:11	106.3	100.3	10:42:41	101.8	95.7
2 F-4 VI	10:45	10:45:43	100.5	93.5	10:46:37	93.6	86.2
1 F-4 SA	10:52	10:52:04	91.4	84.2	10:52:36	95.8	87.8
1 F-4 PA	11:01	10:59:48	107.1	102.4	11:00:17	93.3	96.0
1 F-4 PA	11:14	11:12:25	98.4	92.4	11:12:54	100.0	94.8
1 F-4 PA	11:16	11:14:04	97.4	91.0	11:14:33	97.8	89.5
1 F-4 PA	11:32	11:31:08	109.4	104.0	11:31:39	99.7	94.5
2 F-4 PA	11:36	11:34:27	101.0	94.5	11:34:53	94.5	87.7
		11:39:44	91.8	86.8	11:35:11	77.7	72.3
1 F-4 SA	11:43	11:40:49	99.1	93.2	11:41:20	104:5	97.1
3 F-4 PSG	11:46	11:42:05	91.2	85.0	Recorded At the Same Time		
		11:44:52	90.0	83.5	11:45:45	97.6	88.8
		11:45:16	99.3	92.5			
1 F-4 SA	11:51	11:49:59	107.9	102.6	11:50:30	90.1	81.0
1 F-4 SA	11:59	11:58:58	107.5	102.6	11:59:30	107.4	100.3
2 F-4 VI	12:08	12:10:38	95.2	89.6	Not Recorded		
1 F-4 SA	12:13	12:11:58	108.0	102.3	12:12:28	106.2	99.0

Fig. 16. Event Correlation For Sept 14 Logs At Homestead AFB

Measurement Program ____ Sheet ____ of ____

Site Number	1
Engineer	Robert Lee
Measurement Date	11-21 Sept

Flight Track	A/c	Oper.	No. of Meas., n_i	SEL_i	90% c.i. (+)	90% c.i. (-)	σ_i
05E1	F-4	PA	257	104.5	105.0	104.0	3.05×10^{10}
05J1	F-4	SA	46	107.6	108.8	106.0	7.49×10^{10}
05F1	F-4	TA	23	103.1	104.4	101.1	2.17×10^{10}
05G1	F-4	VI	105	102.6	103.8	100.9	3.71×10^{10}

Fig. 17a. Worksheet 3 for Site 1 at Homestead AFB FL

Measurement Program____ Sheet ___ of ___

Site Number	2
Engineer	Robert Lee
Measurement Date	11 - 21 Sept

Flight Track	A/c	Oper.	No. of Meas., n_i	SEL_i	90% c.i. (+)	90% c.i. (-)	σ_i
05E1	F-4	PA	242	100.6	101.2	100.0	1.4982×10^{10}
05J1	F-4	SA	33	100.0	101.5	97.8	1.3860×10^{10}
05F1	F-4	TA	14	96.7	98.8	92.2	6.8245×10^{9}
05G1	F-4	VI	117	95.6	96.4	94.6	4.8693×10^{9}

Fig. 17b. Worksheet 3 for Site 2 at Homestead AFB FL

Measurement Program ____ Sheet ____ of ____

Site Number	1
Engineer	Robert Lee
Measurement Date	11 - 21 Sept

Flight Track	A/C	Oper.	Adj. SEL_i	N_i	n_i	σ_i
05E1	F-4	PA	104.3	22.42	257	3.06×10^{10}
05J1	F-4	SA	107.4	18.38	46	7.49×10^{10}
05F1	F-4	TA	102.9	4.43	23	2.17×10^{10}
05G1	F-4	VI	102.5	25.71	105	3.71×10^{10}

From Equations in Supplement

DNL		73.9
σ		2.10×10^7
90% c.i.	(+)	76.2
	(-)	68.8

Fig. 18a. Worksheet 4 for Site 1 at Homestead AFB FL

Measurement Program____ Sheet____ of____

Site Number	2
Engineer	Robert Lee
Measurement Date	11 - 21 Sept

Flight Track	A/C	Oper.	Adj. SEL_i	N_i	n_i	σ_i
05E1	F-4	PA	100.3	22.42	242	1.4982×10^{10}
05J1	F-4	SA	98.8	18.38	33	1.3860×10^{10}
05F1	F-4	TA	96.5	4.43	14	6.8245×10^{9}
05G1	F-4	VI	95.4	25.71	117	4.8693×10^{9}

From Equations in Supplement

DNL		67.5
σ		5.10×10^{6}
90% c.i.	(+)	69.9
	(-)	61.6

Fig. 18b. Worksheet 4 for Site 2 at Homestead AFB FL

WORKSHEET 6

CALCULATE THE PROBABILITY THAT THE DNL FROM MEASUREMENTS AND THE DNL FROM NOISEMAP ARE CONSISTENT

Measurement Program____ Sheet___ of___

Site Number 1

Engineer Robert Lee

Date

From Worksheet 3 or Worksheet 6		From Worksheet 4	From NOISEMAP
Measurement Standard Deviation	Measurement DNL	NOISEMAP Standard Deviation	NOISEMAP DNL
σ_S or σ_M	DNL(M) or DNL(S)	σ_i	DNL(C)
2.10×10^7	73.9	1.11×10^7	79.6

Calculated
Parameter Z
2.81

↓

From Table 1
Parameter p
.9975

↓

Calculated
Probability Equals 2 - 2p
.0050

This Value is the Probability that the Measurements and the NOISEMAP Predictions are Consistent.

(The Probability that they are not Consistent is 1 Minus this Value.)

Fig. 19a. Worksheet 6 for Site 1 at Homestead AFB FL

WORKSHEET 6

CALCULATE THE PROBABILITY THAT THE DNL FROM MEASUREMENTS AND THE DNL FROM NOISEMAP ARE CONSISTENT

Measurement Program_____ Sheet___ of___

Site Number 2

Engineer Robert Lee

Date 11 - 21 Sept

From Worksheet 3 or Worksheet 6		From Worksheet 4	From NOISEMAP
Measurement Standard Deviation	Measurement DNL	NOISEMAP Standard Deviation	NOISEMAP DNL
σ_S or σ_M	DNL(M) or DNL(S)	σ_i	DNL(C)
5.10×10^6	67.5	1.71×10^6	69.5

Calculated
Parameter Z
.612

↓

From Table 1
Parameter p
.7291

↓

Calculated
Probability Equals 2 - 2p
.5418

This Value is the Probability that the Measurements and the NOISEMAP Predictions are Consistent.

(The Probability that they are not Consistent is 1 Minus this Value.)

Fig. 19b. Worksheet 6 for Site 2 at Homestead AFB FL

V. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

In summary, the NOISECHECK units operated without problems once we started using the desiccants to keep the moisture out. The units are simple to use and operate. At Laughlin AFB a person was trained to service and calibrate the units in a couple of hours. Security for the units was a problem (one unit was stolen at Homestead AFB) even when the units were chained down. This is always going to remain a problem because there will be times when you will need to monitor in unsecured areas.

These two tests underscore the necessity of obtaining detailed information on only the right operations. This can only be done if the main contributors to the DNL for each site have been identified prior to the test. At Laughlin we tried to identify all the events and ended up with too much information about events that didn't matter and too little information about events that did. This allowed us to make an overall DNL analysis but we couldn't resolve the differences with NOISEMAP. At Homestead AFB we had the right information and we could very easily resolve the measurement differences with NOISEMAP.

In the final analysis, NOISECHECK does provide the capability to spot-check the NOISEMAP predicted values. The equipment works well in very extreme weather conditions. The procedures are straight forward, although complicated, and do produce a single number to tell how close the measurements and NOISEMAP agree that is understandable in normal statistical language. The worksheets are helpful but could be condensed and the SEL analysis makes it easy to identify precisely which operations, if any, are causing a deviation from the NOISEMAP values.

RECOMMENDATIONS

One of the biggest problems with acquiring the NOISECHECK data is the security for the systems. My first recommendation is whenever the NOISECHECK Units have to be placed in an exposed and unattended area that special security boxes be used. Figure 20 gives a diagram of what they should look like. The main features of these boxes are the auger that holds it down from the inside and the bars around the padlock. The auger makes it hard for someone or even several people to just pick up the unit and walk away. The bars around the padlock prevent anyone from using bolt cutters to cut the lock off. If made of a heavy gauge steel, the boxes will also prevent most vandalism from destroying the units.

The biggest problem with preparing for a survey is sorting through the NOISEMAP chronicles to determine the major contributors at each point. My second recommendation is to develop a subroutine for the NOISEMAP program, that would list out the information on each aircraft/flight track/operation for a specified ground location. The program would also rank order this information by its LDN contribution to the selected location. The subroutine should be able to handle about ten locations and print out the information in the format laid out in Figure 21. Each printout page would be a summary analysis of each location and could be directly input into the NOISECHECK analysis. This would become the cornerstone of the NOISECHECK program for two reasons. 1. It would provide a way to check the NOISEMAP inputs at a specific location prior to undertaking an expensive NOISECHECK test, and 2. It would be the screening device needed to concentrate the data collection efforts on only the events that are important to each location. I estimate that this subroutine could cut the amount of time and effort to do an adequate NOISECHECK study in half. This would streamline and simplify the whole NOISECHECK technology making it easier to comprehend when the cases do go to court.

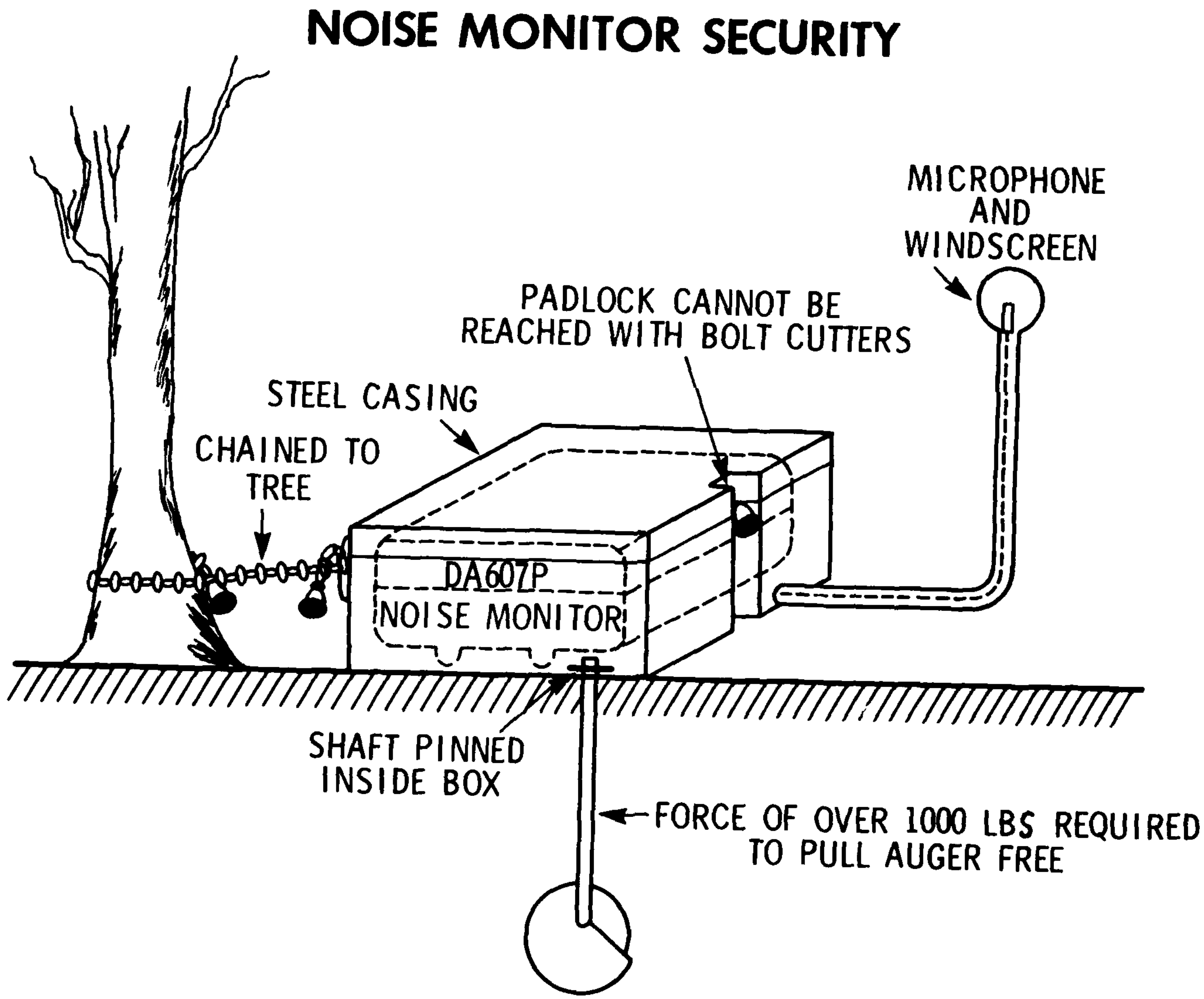


Figure 20. Proposed Noise Security Cases

Site Number________ Site Location___°___'___.___"___ Date Run______________

___°___'___.___"___

A/C	Flt Trk	Power Setting	Airspeed	ALT	Slant Distance	Elevation Angle	No of Events Day	Night	SEL	LDN_i	Rank	Total DNL	Variance*	σ_i**
											1			
											2			
											3			
											4			
											5			
											6			
											7			
											8			
											9			
											10			

DNL(c)____________

σ_c ____________

90% CI $\left\{ \begin{matrix} + \\ - \end{matrix} \right.$ ____________

* Variance is from Figure D-6 in Appendix D

** $\sigma_i = N_i \left[\text{antilog } (SEL_i + \sqrt{\text{variance}_i} \ /10 - \text{antilog } (SEL_{i/10}) \right]$

$$\sigma_c = \frac{\sqrt{\sum_{i=1}^{l} \sigma_i^2}}{86,400}$$

$$90\% \text{ CI} = 10 \log \left[\text{antilog}(DNL(c)/10 \pm 1.645\ \sigma_c/\sqrt{l} \right]$$

Fig. 21. LDN_i Summary Sheet

APPENDIX A

LAUGHLIN AFB DATA

TABLE A-1

HOURLY NOISE LEVELS (dB) AT LAUGHLIN AFB

	Wednesday, Feb 14					Thursday, Feb 15				
Hour	Site 1	Site 2	Site 3	Site 4	Operation	Site 1	Site 2	Site 3	Site 4	Operation
1 2					Takeoffs	29.7 29.7			32.3 31.4	Takeoffs
3 4						29.6 31.1			35.4 36.9	
5 6						29.8 31.1			32.8 38.7	
7 8						31.1 30.8			33.9 34.1	
9 10						34.4 34.5			33.9 61.8	
11 12				81.4 88.2		36.1 Cal	 68.5	69.6 72.2	79.9 79.0	
13 14				81.7 86.3		Bad 	75.0 70.9	86.7 85.9	88.8 84.2	
15 16	 59.6			83.5 82.2		60.1 58.4	71.5 74.2	83.2 81.0	85.5 83.1	
17 18	59.5 53.4			85.[illegible] 81.6		53.4 53.5	68.5 75.3	76.6 81.0	75.1 82.2	Landings
19 20	53.6 60.2			79.7 81.5		41.7 27.8	69.9 26.5	71.7 33.1	67.6 36.5	
21 22	43.1 30.1			73.7 34.5		28.1 38.3	25.5 40.5	35.8 45.3	35.5 48.3	
23 24	30.5 27.7			33.7 33.1		38.5 38.2	41.3 41.8	43.9 44.2	44.0 43.8	
DNL				80.2			67.7	77.7	79.1	
CNEL				80.2			67.7	77.7	79.1	

TABLE A-1

HOURLY NOISE LEVELS (dB) AT LAUGHLIN AFB

	Friday, Feb 16					Saturday, Feb 17				
Hour	Site 1	Site 2	Site 3	Site 4	Operation	Site 1	Site 2	Site 3	Site 4	Operation
1	35.6	40.0	57.9	52.3			23.3	34.4	35.0	
2	33.1	28.0	36.9	32.5			23.1	35.6	35.1	
3	35.4	33.4	40.5	36.0			22.7	34.9	34.4	
4	35.5	33.9	41.7	36.8			23.1	35.0	33.2	
5	36.3	35.7	43.0	36.5			23.0	34.7	33.1	
6	37.3	38.5	45.9	39.3			24.1	38.5	36.4	
7	38.0	39.5	48.0	41.7			26.2	37.8	35.8	
8	38.1	53.0	64.9	65.5			26.7	38.1	35.3	
9	38.5	59.1	71.8	75.5			25.3	38.6	36.0	
10	Bad	62.9	75.6	81.6			44.4	50.3	38.2	
11	Cal	73.4	79.9	83.3			43.4	66.9	51.5	
12		72.4	80.8	79.0	Landings		45.5	48.7	48.8	Landings
13		69.0	77.0	75.5			35.6	39.6	39.1	
14		70.0	79.7	81.8			35.1	38.5	37.7	
15		69.2	81.3	76.7			36.7	40.0	38.4	
16		53.4	77.3	69.0			36.2	39.2	38.1	
17		62.3	75.3	74.1			36.4	38.5	37.9	
18		61.6	72.3	68.1			45.3	39.8	37.0	
19		50.2	55.3	66.3			31.4	37.0	36.5	
20		25.5	39.4	38.2			29.4	32.8	32.7	
21		23.8	37.7	37.1			33.4	39.0	37.0	
22		24.1	36.5	37.6			35.1	38.1	38.0	
23		23.5	36.5	36.3			29.8	33.8	32.2	
24		22.3	32.9	33.8			27.3	31.5	30.6	
DNL		64.9	74.5	74.2			38.9	53.6	43.4	
CNEL		64.9	74.5	74.2			39.1	53.7	43.4	

TABLE A-1

HOURLY NOISE LEVELS (dB) AT LAUGHLIN AFB

	Sunday, Feb 18					Monday, Feb 19				
Hour	Site 1	Site 2	Site 3	Site 4	Operation	Site 1	Site 2	Site 3	Site 4	Operation
1		31.5	38.6		Landings		28.2	29.6	30.0	Holiday
2		28.2	32.1				28.1	31.4	31.2	
3		35.8	39.1				29.3	31.7	31.1	
4		34.0	39.8	38.9			29.9	34.1	33.3	
5		32.9	39.0	38.0			29.9	32.4	33.2	
6		31.7	34.4	35.8			25.6	28.1	27.9	
7		28.9	30.5	32.9			31.9	30.9	30.6	
8		28.8	32.8	35.1			32.1	32.5	32.6	
9		46.5	40.7	42.1			36.3	35.1	33.4	
10		32.8	36.1	37.5			46.3	42.9	50.8	
11		36.5	37.4	39.7			21.3	40.7	38.3	
12		48.9	51.3	59.7			21.8	40.6	39.1	
13		36.3	41.4	38.9			26.6	41.1	39.1	
14		47.3	44.2	62.2			27.1	42.1	39.0	
15		59.5	63.7	63.6			21.9	42.6	40.1	
16		54.3	61.5	69.4			53.7	68.2	76.4	
17		43.9	48.0	57.1			35.1	51.9	68.4	
18		31.8	34.4	32.9			23.7	46.0	44.0	
19		35.3	39.4	37.0			22.3	43.4	41.4	
20		26.4	31.2	29.6			22.5	44.3	43.1	
21		26.4	29.3	29.4			23.2	46.0	43.5	
22		29.7	30.5	30.8			22.1	42.6	41.7	
23		30.1	31.1	28.7			21.3	39.0	37.5	
24		31.1	30.1	29.4			21.1	37.1	36.3	
DNL		47.9	52.7	57.7			41.9	54.9	63.3	
CNEL		47.9	52.7	57.7			41.9	55.0	63.3	

TABLE A-1

HOURLY NOISE LEVELS (dB) AT LAUGHLIN AFB

	Tuesday, Feb 20					Wednesday, Feb 21				
Hour	Site 1	Site 2	Site 3	Site 4	Operation	Site 1	Site 2	Site 3	Site 4	Operation
1		22.0	41.3	38.6	Takeoffs		25.7	34.2	30.7	Takeoffs
2		21.0	34.4	36.4			33.9	48.5	38.1	
3		21.1	34.1	33.7			27.5	35.8	32.0	
4		21.0	32.0	31.6			27.9	34.6	32.8	
5		21.0	31.8	32.0			25.6	29.4	31.3	
6		21.0	32.0	32.3			26.1	30.4	29.5	
7		21.0	32.3	32.5			69.4	77.1	76.7	
8		21.0	30.5	31.4			72.6	80.2	79.8	
9		23.6	29.3	30.3			79.3	86.2	86.4	
10		62.5	64.8	75.3			75.9	81.5	84.0	
11		57.4	58.3	66.7			72.4	72.1	77.8	
12		74.4	75.5	85.4			68.3	72.3	76.1	
13		74.8	77.0	81.1			75.6	76.3	82.5	
14		66.1	66.8	76.4			70.5	72.5	73.5	
15		77.1	76.4	76.8	Landings		66.5	66.1	75.6	
16		76.0	77.5	81.1			33.5	41.8	35.7	
17		74.2	81.1	81.8			38.7	43.0	42.2	
18		78.2	78.5	83.1			59.6	59.9	74.2	
19		76.0	80.5	83.0			25.5	28.7	33.4	
20		34.1	34.3	36.9			24.8	27.8	30.3	
21		33.2	33.8	35.1			25.0	28.0	30.9	
22		38.1	38.7	39.1			26.6	29.8	31.4	
23		32.2	41.3	38.0			23.7	26.8	29.3	
24		27.5	33.4	32.3			24.8	27.2	29.9	
DNL		70.8	73.3	77.4			71.1	77.2	78.3	
CNEL		70.8	73.3	77.4			71.1	77.2	78.3	

TABLE A-1

HOURLY NOISE LEVELS (dB) AT LAUGHLIN AFB

	Thursday, Feb 22					Friday, Feb 23				
Hour	Site 1	Site 2	Site 3	Site 4	Operation	Site 1	Site 2	Site 3	Site 4	Operation
1		24.1	27.9	30.1			31.6	33.8	33.8	
2		24.0	27.0	29.6			25.0	28.6	30.6	
3		23.9	26.9	29.5			25.5	29.8	31.0	
4		24.1	26.9	30.0			27.0	35.8	31.9	
5		24.1	27.2	30.3			26.5	35.0	32.1	
6		25.8	27.1	30.6			26.5	32.5	30.5	
7		27.2	27.6	31.1			27.8	29.1	29.1	
8		27.6	29.6	32.6			45.3	73.4	50.2	
9		33.0	29.7	32.0				82.4	77.3	
10		33.4	32.9	34.1				80.1	82.1	
11		62.6	62.0	74.8				77.5	82.6	
12		73.1	71.9	80.0	Takeoffs		Bad	81.5	84.9	Landings
13		76.5	75.6	84.1				82.4	77.4	
14		59.9	63.3	69.2				82.0	81.4	
15		141.2*	79.4	84.3				80.3	81.0	
16		81.6	85.2	84.5				77.7	82.4	
17			85.6	84.7				76.4	74.6	
18			83.7	83.0				75.5	79.7	
19		73.3	80.1	78.9				80.0	73.3	
20		62.9	69.5	66.2				29.3	30.5	
21		49.3	55.1	58.4				37.8	36.8	
22		28.6	31.6	31.9				30.6	29.7	
23		25.7	27.6	29.1				33.3	33.5	
24		32.1	34.1	34.8				29.5	30.1	
DNL			77.0	78.0				76.9	77.5	
CNEL			77.0	78.1				76.9	77.5	

*Equipment malfunction

TABLE A-1

HOURLY NOISE LEVELS (dB) AT LAUGHLIN AFB

	Saturday, Feb 24					Sunday, Feb 25				
Hour	Site 1	Site 2	Site 3	Site 4	Operation	Site 1	Site 2	Site 3	Site 4	Operation
1			30.1		Landings			34.1	36.2	Landings
2			34.0					32.5	31.1	
3			33.1	33.0				35.9	38.6	
4			29.5	30.7				30.5	31.9	
5			34.3	31.8				40.2	40.0	
6			31.0	31.1				38.1	36.9	
7			39.9	38.7				33.9	30.0	
8			46.3	40.8				40.9	38.7	
9			52.4	45.7				44.0	39.1	
10			53.5	47.0				44.3	38.9	
11			52.0	54.7				45.0	35.9	
12			60.7	54.9				72.9	57.7	
13			69.9	63.5				67.7	77.2	
14			64.7	51.1				69.8	71.3	
15			72.5	55.0				66.8	75.3	
16			67.9	60.0				73.0	79.1	
17			80.9	83.3				55.8	54.9	
18			65.3	76.9				64.1	57.2	
19			49.1	40.4				34.7	35.2	
20			35.5	32.0				34.7	35.4	
21			41.2	39.4				30.8	30.0	
22			40.9	39.3				27.7	31.5	
23			28.6					27.5	30.6	
24			28.7					36.1	36.0	
DNL			68.4	70.5				64.2	68.9	
CNEL			68.4	70.5				64.2	68.9	

TABLE A-1

HOURLY NOISE LEVELS (dB) AT LAUGHLIN AFB

	Monday, Feb 26					Tuesday, Feb 27				
Hour	Site 1	Site 2	Site 3	Site 4	Operation	Site 1	Site 2	Site 3	Site 4	Operation
1			32.1		Takeoffs			41.4	40.1	Takeoffs
2			31.1					37.5	35.4	
3			30.1	31.6				37.8	35.7	
4			29.7	30.8				38.6	36.5	
5			27.8	28.7				32.1	31.5	
6			30.4	29.9				30.4	27.3	
7			31.5	32.4				63.6	66.8	
8			74.5	80.6				76.7	82.1	
9			79.3	82.2				83.8	82.1	
10			79.5	81.8				81.1	85.5	
11			79.7	82.0				85.1	85.2	
12			83.6	84.6				84.2	84.5	
13			82.4	79.5				84.2	83.1	
14			82.3	83.9				85.2	84.4	
15			82.3	82.8				85.4	85.1	
16			84.2	83.1				82.7	84.6	
17			82.9	81.9				83.5	84.5	
18			79.0	77.0				85.2	85.1	
19			76.7	68.0				83.1	78.1	
20			59.0	61.6				55.7	38.2	
21			57.4	59.0				39.5	38.6	
22			32.4	33.1				36.1	33.8	
23			33.8	34.0				53.6	45.9	
24			34.8	33.3				29.3	30.6	
DNL			78.4	78.7				80.9	81.1	
CNEL			78.4	78.7				80.9	81.1	

TABLE A-1

HOURLY NOISE LEVELS (dB) AT LAUGHLIN AFB

	Wednesday, Feb 28					Thursday, Mar [illegible]				
Hour	Site 1	Site 2	Site 3	Site 4	Operation	Site 1	Site 2	Site 3	Site 4	[illegible]
1 2			31.0 35.4	31.9 34.0	Landings			28.8 27.9	[illegible] [illegible]	Takeoffs
3 4			30.2 37.1	30.1 31.8				32.5 32.2	[illegible] 30.8	
5 6			39.1 37.6	39.9 34.9				29.3 32.7	[illegible] [illegible]	
7 8			68.4 80.3	47.2 68.3				62.3 59.9	70.0 66.5	
9 10			75.5 81.1	76.0 74.4				74.9 76.0	75.3 82.3	
11 12			72.6 80.7	76.1 87.6				67.1 66.3	72.2 75.6	
13 14			78.9 78.5	79.3 81.1				81.0 78.4	78.2 81.8	
15 16			82.2 76.8	81.0 80.0				80.7 82.7	84.0 83.3	
17 18			76.9 74.8	80.2 78.3				82.4 83.0	83.3 83.7	
19 20			70.0 75.4	74.4 66.6				80.9 83.4	75.7 74.7	
21 22			78.2 71.3	67.1 61.9				82.3 78.7	74.4 70.7	
23 24			35.1 36.1	31.3 34.2				50.1 47.3	49.9 47.2	
DNL			76.4	[illegible]				78.1	78.3	
CNEL			77.2	77.6				80.2	78.6	

TABLE A-1

HOURLY NOISE LEVELS (dB) AT LAUGHLIN AFB

	Friday, Mar 2					Saturday, Mar 3				
Hour	Site 1	Site 2	Site 3	Site 4	Operation	Site 1	Site 2	Site 3	Site 4	Operation
1 2			48.8 47.0	46.5 45.3	Takeoffs			39.7 41.0	39.8 39.9	Takeoffs
3 4			45.4 46.7	43.3 46.1				33.6 39.0	35.3 38.0	
5 6			46.5 41.0	45.4 39.3				34.3 37.9	34.8 37.8	
7 8			38.7 41.8	39.6 44.5				38.1 37.1	37.2 35.3	
9 10			67.1 74.7	63.3 80.6				40.9 53.2	40.0 52.4	
11 12			70.7 53.4	80.5 55.4				58.3 67.0	55.8 50.4	
13 14			67.4 82.1	76.6 85.2				62.1 69.4	64.9 57.1	
15 16			83.2 79.4	82.1 82.8				68.4 59.6	73.6 48.7	
17 18			84.0 63.4	79.1 74.4				75.1 52.7	77.0 41.7	
19 20			50.8 59.2	50.9 53.7				53.6 55.7	51.7 51.7	
21 22			46.1 47.3	43.4 43.1				41.7 35.6	39.7 36.4	
23 24			47.9 41.5	43.6 37.7				37.3 36.4	34.7 36.0	
DNL			75.1	76.5				63.9	65.1	
CNEL			75.1	76.5				64.0	65.1	

TABLE A-1

HOURLY NOISE LEVELS (dB) AT LAUGHLIN AFB

	Sunday, Mar 4					Monday, Mar 5				
Hour	Site 1	Site 2	Site 3	Site 4	Operation	Site 1	Site 2	Site 3	Site 4	Operation
1			32.0	33.0				29.9	29.1	
2			30.5	30.1				30.1	29.7	
3			30.1	30.5				30.2	29.3	
4			29.2	29.2				30.5	29.4	
5			30.8	29.6				30.6	29.4	
6			31.1	34.4				30.9	29.4	
7			36.4	36.0				59.4	69.3	
8			36.1	37.4				75.8	81.7	
9			33.7	41.0				83.4	83.5	
10			36.3	36.3				81.8	83.3	
11			37.9	35.0	Takeoffs			83.0	82.6	Takeoffs
12			60.7	53.8				82.5	83.0	
13			48.2	69.4				83.3	82.5	
14			74.7	79.5				83.0	85.7	
15			74.6	71.5						
16			68.4	65.7						
17			60.2	58.6						
18			42.9	42.5						
19			45.1	46.5						
20			38.1	35.7						
21			27.0	28.4						
22			30.5	28.7						
23			28.7	30.1						
24			29.2	29.8						
DNL			64.5	67.0				77.0	78.3	
CNEL			64.5	67.0						

TABLE A-2

WEATHER AT LAUGHLIN AFB

	Feb 14		Feb 15		Feb 16		Feb 17		Feb 18		Feb 19		Feb 20	
Hour	°F	%	°F	%	°F	%	°F	%	°F	%	°F	%	°F	%
1	57	74	60	77	47	63	32	63	33	75	37	78	42	79
2	55	77	60	77	47	60	32	63	32	78	35	84	42	82
3	55	77	59	86	46	60	32	61	31	81	33	89	41	93
4	53	79	59	89	44	62	31	63	30	84	32	88	41	96
5	52	86	56	96	43	65	31	66	31	81	32	92	41	96
6	53	93	55	96	40	75	30	68	31	78	31	92	41	100
7	52	96	54	96	38	78	29	71	30	81	31	92	41	100
8	53	96	57	96	37	72	29	71	31	78	32	92	41	100
9	55	100	58	100	37	64	29	74	34	72	33	92	43	96
10	57	93	60	100	36	61	30	74	38	61	35	88	44	96
11	61	83	64	84	36	58	31	68	43	55	37	81	44	96
12	64	75	65	81	36	56	33	63	45	53	38	78	45	93
13	70	61	72	63	36	54	34	63	49	48	40	73	47	86
14	73	55	73	59	36	54	37	58	50	46	44	65	48	86
15	76	48	80	41	35	53	39	54	52	46	45	65	52	73
16	80	39	84	27	35	53	39	54	54	44	44	65	55	68
17	80	39	83	27	35	53	41	50	54	44	45	60	56	66
18	78	42	81	28	35	56	41	52	54	46	43	65	55	68
19	70	54	75	35	34	58	40	54	49	54	42	67	54	68
20	70	54	68	47	34	58	38	61	43	62	41	70	51	76
21	65	65	59	61	34	58	37	66	41	67	41	73	49	79
22	64	67	60	49	33	61	36	69	39	72	39	78	47	82
23	62	72	54	54	33	61	35	72	39	72	39	78	44	89
24	62	72	49	58	33	63	34	75	38	75	41	79	41	93
Ave	63°	71%	64°	68%	38°	61%	NA		NA		Holiday		46°	86%
Ave (Ops)	70°	59%	74°	55%	36°	58%	NA		NA		NA		50°	80%

TABLE A-2

WEATHER AT LAUGHLIN AFB

	Feb 21		Feb 22		Feb 23		Feb 24		Feb 25		Feb 26		Feb 27	
Hour	°F	%	°F	%	°F	%	°F	%	°F	%	°F	%	°F	%
1	40	96	56	100	52	100	57	89	46	65	41	59	52	54
2	39	96	55	100	53	100	56	93	44	67	38	67	51	56
3	38	96	55	100	55	96	57	93	43	70	37	66	51	66
4	39	96	55	100	58	93	59	96	42	73	36	69	50	68
5	39	96	55	100	57	96	59	96	43	70	33	75	47	76
6	39	96	55	100	56	96	56	86	41	73	33	75	46	76
7	38	96	55	100	56	96	50	73	40	72	32	75	46	79
8	39	93	55	100	54	96	52	71	42	73	39	61	47	79
9	44	96	56	100	59	89	55	63	45	55	46	51	51	76
10	48	92	58	96	64	62	56	56	48	45	50	44	56	68
11	52	85	69	96	67	50	60	45	50	40	53	41	60	59
12	56	83	62	93	73	32	62	39	53	36	57	35	62	57
13	55	89	66	78	77	27	68	24	57	33	60	33	65	51
14	55	93	68	73	78	27	69	22	59	30	63	28	70	43
15	55	96	70	68	79	26	71	20	61	28	65	28	70	45
16	56	96	71	66	78	26	70	21	62	27	64	28	72	44
17	56	96	72	61	79	25	69	20	62	25	64	28	72	42
18	56	100	72	63	77	26	68	19	61	25	63	28	72	42
19	56	100	65	78	72	32	63	20	57	30	60	32	66	48
20	56	100	59	89	66	41	57	29	53	36	57	37	62	57
21	55	100	58	89	62	47	57	49	47	48	54	43	59	64
22	55	100	58	89	62	49	53	56	42	60	54	43	58	64
23	55	100	57	96	57	68	51	56	40	67	54	43	52	76
24	55	100	56	96	58	80	49	58	39	67	54	43	52	79
Ave	49°	95%	60°	80%	65°	62%	NA		NA		50°	47%	58°	61%
Ave (Ops)	50°	92%	67°	77%	73°	38%	NA		NA		57°	36%	62°	56%

TABLE A-2

WEATHER AT LAUGHLIN AFB

	Feb 28		Mar 1		Mar 2		Mar 3		Mar 4		Mar 5			
Hour	°F	%	°F	%	°F	%	°F	%	°F	%	°F	%	°F	%
1	54	73	46	62	62	80								
2	53	73	45	65	61	83								
3	50	89	49	54	60	89								
4	49	93	49	56	60	93								
5	44	96	51	54	60	93								
6	45	68	53	58	60	93								
7	42	73	51	68	60	100								
8	46	63	54	71	61	96								
9	56	45	56	80	62	100								
10	62	38	58	80	65	93								
11	63	38	58	83	62	90								
12	65	34	59	83	71	78								
13	67	32	64	70	73	71								
14	69	31	67	63	76	64								
15	71	27	68	61	76	62								
16	71	25	68	61	79	56								
17	72	23	68	63	77	57								
18	71	23	67	65	78	55								
19	67	24	65	72	71	75								
20	66	28	64	75	59	71								
21	62	33	64	75	60	66								
22	51	54	65	70	59	59								
23	50	54	64	72	57	54			Busy Day		Total Day			
24	48	58	63	77	54	56								
Ave	58°	50%	59°	68%	65°	76%			56°	70%				
Ave (Ops)	64°	35%	62°	71%	72°	73%			61°	60%				

TABLE A-3

RSU OBSERVER FLIGHT TRACK UTILIZATION COUNTS
AT LAUGHLIN AFB TX

T-38 Operations	Straight-Out Departure	Crosswind Pattern	Closed Pattern
Left Runway			
Operations Observed	4	32	225
% Utilization	2%	12%	86%
Center Runway			
Operations Observed	79	11	4
% Utilization	84%	12%	4%

T-37 Operations	Straight-Out Departure	Depart 10°	Crosswind Pattern	Closed Pattern
Right Runway				
Operation Observed	4	15	17	34
% Utilization	6%	21%	24%	49%

TABLE A-4

TOTAL BASE TRAFFIC COUNT
AT LAUGHLIN AFB TX

Operations Over NOISECHECK Units = Count/2*

Date	Operation	Tower Count	Lariat Count	Honcho Count	# T-38s Flying	# T-37s Flying
Feb 14	Takeoffs	278	620	430	122	99
Feb 15	Takeoffs	62	426	392	55	72
Feb 15	Landings	162	310	202	40	37
Feb 16	Landings	364	500	770	66	82
Feb 17	Saturday	4				
Feb 18	Sunday	16				
Feb 19	Holiday	0				
Feb 20	Takeoff	240	98	108	27	19
Feb 20	Landings	24	190	240	53	43
Feb 21	Takeoffs	234	262	300 est	69	40
Feb 22	Takeoffs	244	1420	260	150 est	57
Feb 23	Landings	282	892	678	150	135
Feb 24	Saturday	24				
Feb 25	Sunday	92				
Feb 26	Takeoffs	426	1000	710	132	158
Feb 27	Takeoffs	508	938	752	150	169
Feb 28	Landings	312	1020	1006	151	179
Mar 1	Takeoffs	692	615	316	104	93
Mar 2	Takeoffs	204	272	166	56	21

* 1 Takeoff and 1 Landing = Count of 2

TABLE A-5

T-38 DAILY OPERATIONS
AT LAUGHLIN AFB TX

Date	Operation	Center Runway St Out	Center Runway Crosswind	Center Runway Closed	Left Runway St Out	Left Runway Crosswind	Left Runway Closed
Feb 14	Takeoff	117	17	5	6	37	267
Feb 15	Takeoff	26	4	1	4	26	183
Feb 15	Landing	81			3		152
Feb 16	Landing	182		5			245
Feb 17	Saturday						
Feb 18	Sunday						
Feb 19	Holiday						
Feb 20	Takeoff	101	14	5	1	6	42
Feb 20	Landing	12			2		93
Feb 21	Takeoff	98	14	5	3	16	113
Feb 22	Takeoff	102	15	5	14	85	611
Feb 23	Landing	141			9		437
Feb 24	Saturday						
Feb 25	Sunday						
Feb 26	Takeoff	179	26	9	10	60	430
Feb 27	Takeoff	213	30	10	9	56	403
Feb 28	Landing	156			10		500
Mar 1	Takeoff	291	42	14	6	37	264
Mar 2	Takeoff	86	12	4	3	16	117
Average Busy Day		12 Busy Days During Field Test					
Takeoffs		101.0	14.5	4.8	4.7	28.2	202.5
Landings		47.7	0	0	2.5	0	118.9

TABLE A-6

T-37 DAILY OPERATIONS
AT LAUGHLIN AFB TX

Date	Operation	Depart	Depart 10°	Crosswind	Closed
Feb 14	Takeoffs	13	45	52	105
Feb 15	Takeoffs	12	41	47	96
Feb 15	Landings	27			64
Feb 16	Landings	104			281
Feb 17	Saturday				
Feb 18	Sunday				
Feb 19	Holiday				
Feb 20	Takeoffs	3	11	13	26
Feb 20	Landings	32			76
Feb 21	Takeoffs	9	32	36	74
Feb 22	Takeoffs	8	27	31	64
Feb 23	Landings	91			247
Feb 24	Saturday				
Feb 25	Sunday				
Feb 26	Takeoff	21	75	85	174
Feb 27	Takeoff	22	79	90	184
Feb 28	Landing	136			367
Mar 1	Takeoffs	10	33	38	77
Mar 2	Takeoffs	5	17	20	41
Average Busy Day		12 Busy Days During Field Test			
Takeoffs		8.6	30.0	34.3	70.1
Landings		32.6	0	0	86.2

TABLE A-7

PILOT SUMMARY OF OPERATING PARAMETERS AT POINT OF CLOSEST APPROACH TO MICROPHONE LOCATIONS AT LAUGHLIN AFB TX

	Site 2 Takeoff	Site 3 Takeoff	Site 4 Takeoff
T-38	15,600 ft. from brake release	10,800 ft. from brake release	12,600 ft. from brake release
Power setting	Mil power	A/B or Mil	Mil power
Airspeed	290 kts	230 kts	200 kts
Altitude	600 ft	400 ft	500 ft
T-37			
Power setting	Mil power	Mil power	Mil power
Airspeed	180 kts	140 kts	160 kts
Altitude	1000 ft	300 ft	500 ft

TABLE A-8

SUMMARY OF ALTITUDE VERIFICATION FROM PHOTOS

	T-38 Depart Center	T-38 Cross-wind Left	T-37 Depart	T-37 Cross-wind	T-37 Closed
Site 4					
#Photos	1	2	1	1	2
Average Slant Distance	638 ft	1965 ft	1007 ft	2198 ft	3472 ft

	T-38 Landing Left
Site 3	
# Photos	3
Average Slant Distance	414 ft

	T-38 Depart Center	T-38 Depart Left	T-38 Cross-wind Left	T-38 Closed Left	T-38 Depart
Site 2					
# Photos	3	2	5	13	4
Average Slant Distance	1812 ft	702 ft	2025 ft	3620 ft	2323 ft

APPENDIX B

HOMESTEAD AFB DATA

TABLE B-1

HOURLY NOISE LEVELS (dB) AT HOMESTEAD AFB

	September 11				September 12			
Hour	Site 1	Site 2	Site 3	Operation	Site 1	Site 2	Site 3	Operation
1				Landings			45.0	Landings
2							45.8	
3							47.1	
4	44.2						46.2	
5	43.7						44.6	
6	42.5						43.4	
7	44.7						50.0	
8	57.4						50.0	
9	65.3						44.4	
10	70.5	49.0			80.5	67.3	69.2	
11	81.6	72.7			79.8	67.9	72.2	Takeoffs
12	76.8	69.5			82.5	72.1	71.4	
13	75.4	70.9			61.4		59.4	
14	75.4	67.5			81.5	74.4	67.3	
15	74.8	66.0			System died	72.9	72.7	
16	76.3	70.7				68.4	71.1	
17	73.3	Jammed	58.8			70.5	70.1	
18	78.3		60.8				67.8	
19	78.9		63.7			65.5	66.9	
20	82.1		51.5					
21	76.3		65.7			71.0		Landings
22	77.2		64.8			70.4		
23	79.9		58.5			64.9		
24			42.8					
DNL	79.0	69.6			76.2	69.0		
CNEL	79.8					69.2		

TABLE B-1

HOURLY NOISE LEVELS (dB) AT HOMESTEAD AFB

	September 13				September 14			
Hour	Site 1	Site 2	Site 3	Operation	Site 1	Site 2	Site 3	Operation
1				Landings	49.2		46.5	Takeoffs
2					50.4		49.1	
3					55.9		62.3	
4					49.0		46.4	
5					48.9		43.5	
6					56.7		52.6	
7					48.9		47.7	
8		49.3			50.1		52.3	
9		49.3		Takeoffs	46.5		41.7	
10		70.4			76.4	70.6	53.0	Landings
11		76.1			79.6	73.9	66.5	
12		72.5			80.4	76.0	58.8	
13	75.3	68.1	67.1		76.8	73.6	62.5	
14	79.6	76.7	57.9		73.2	71.2	57.8	
15	77.8	68.7	69.2		77.2	73.3	54.5	
16	81.9	69.4	69.7		66.0	60.3	53.3	
17	74.1	71.2	62.2		76.9	70.3	64.0	
18	68.5	62.6	57.0		70.1	64.5	60.9	
19	77.8	71.0	67.3		77.8	60.7	62.7	
20	77.9	68.1	71.1		59.1	45.9	51.3	
21	74.7	60.8	71.0		71.3	67.4	52.5	
22	59.7	50.2	66.1		81.4	76.1	61.2	
23	61.8		62.0		71.6	67.4	53.2	
24	51.1		54.9		57.7		47.0	
DNL	75.7		68.9		75.3	70.8	62.2	
CNEL	75.8		69.0		76.7	71.6	62.6	

TABLE B-1

HOURLY NOISE LEVELS (dB) AT HOMESTEAD AFB

	September 15				September 16			
Hour	Site 1	Site 2	Site 3	Operation	Site 1	Site 2	Site 3	Operation
1	59.9		45.5	Landings	53.1		44.8	Landings
2	70.4	62.4	47.9		54.7		45.4	
3	59.8		46.6		56.7		45.9	
4	57.0		49.3		57.0		45.8	
5	71.1	64.5	53.0		52.6		45.8	
6	56.0		63.2		56.9		43.8	
7	50.5		76.9		48.9		41.0	
8	64.4	54.0	37.5		46.3		40.1	
9	67.6	56.9	51.7		55.3		49.9	
10	66.4	61.6	54.8		58.6	42.5	48.4	
11	65.1	61.2	48.6		53.4	42.5	49.9	
12	59.0	49.6	46.4		52.6		60.9	
13	53.8		56.8		63.4	55.1	66.3	
14	52.9		49.6		53.1		49.4	
15	54.7		51.9		53.4		51.5	
16	56.1		63.0		50.3		48.3	
17	78.5	68.7	66.7		50.0		45.8	
18	69.0	68.5	52.6		75.7	72.0	56.6	
19	48.7		44.4		49.5		47.3	
20	75.7	70.2	55.1		71.6	64.2	47.4	
21	83.5	73.3	56.6		69.8	65.8	46.9	
22	52.0		43.1		53.9		44.0	
23	53.7		43.4		53.1		47.3	
24	50.9		44.9		53.4		44.9	
DNL	74.2	67.0	73.4		65.9	61.6	56.1	
CNEL	76.8	68.2	73.4		67.7	61.8	56.2	

TABLE B-1

HOURLY NOISE LEVELS (dB) AT HOMESTEAD AFB

	September 17				September 18			
Hour	Site 1	Site 2	Site 3	Operation	Site 1	Site 2	Site 3	Operation
1	54.4		45.5		54.8		44.9	
2	54.7		45.1		51.4		44.8	
3	55.9		45.6		51.6		46.4	
4	56.8		46.1		68.9	64.0	46.4	
5	52.9		48.3		50.8		45.4	
6	52.4		43.0		51.2		46.4	
7	51.4		62.6		52.7		54.9	
8	63.9	61.0	40.2		50.4		69.2	
9	50.3		41.4		58.2	41.2	69.9	
10	68.4	66.8	64.4		78.9	70.8	67.0	
11	74.4	72.3	63.7		80.3	77.9	NOISE-	
12	76.6	73.8	65.6	Landings	74.8	71.0	CHECK	Landings
13	75.2	72.5	61.4		67.9	63.7	Unit	
14	76.6	73.6	61.7		71.3	68.5	Stolen	
15	64.4	58.5	66.1		79.5	76.4		
16	78.3	75.0	62.9		62.1	59.9		
17	70.9	65.0	68.0		76.2	72.4		
18	79.4	78.8	68.4		72.8	66.2		
19	63.3	32.9	72.5		87.7	68.8		
20	59.2		68.9		81.0	73.8		
21	54.4		66.1		71.3	63.1		
22	79.8	77.3	69.7		69.9	65.4		
23	56.1	47.6	49.6		76.0	71.7		
24	58.2	55.9	66.2		56.1			
DNL	72.9	70.7	67.4		78.3	72.3		
CNEL	74.4	71.8	68.6		79.9	72.6		

TABLE B-1

HOURLY NOISE LEVELS (dB) AT HOMESTEAD AFB

	September 19				September 20			
Hour	Site 1	Site 2	Site 3	Operation	Site 1	Site 2	Site 3	Operation
1	70.8	64.3		Landings	53.0			
2	53.8				54.9			
3	59.0				52.9			
4	54.3				53.1			
5	51.0				51.0			
6	49.6				48.1			
7	48.7				58.1			
8	50.9				57.8	33.0		
9	55.3				71.3			
10	55.4				73.8	59.9		
11	76.7	62.0			70.9	59.4		
12	72.4	70.1			75.7	71.7		
13	77.6	75.5			70.8	71.1		
14	82.9	75.4			76.9	72.4		
15	64.8	40.8			61.8	59.4		
16	73.8	74.5			69.8	60.9		
17	78.6	74.4			74.3	69.3		
18	78.7	75.1			75.1	72.3		
19	63.1	53.4			59.1	65.2		
20	57.1				77.5	73.8		
21	82.6	77.7			77.4	75.2		
22	73.8	64.7			81.5	73.9		
23	74.8	70.3			74.7	65.7		
24	70.2	65.0			54.9	59.4		
DNL	77.1	72.4			75.2	69.7		
CNEL	78.4	73.4			77.4	71.9		

AD-A113 672 AIR FORCE AEROSPACE MEDICAL RESEARCH LAB WRIGHT-PATT--ETC F/G 20/1
FIELD STUDIES OF THE AIR FORCE PROCEDURES (NOISECHECK) FOR MEAS--ETC(U)
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UNCLASSIFIED AFAMRL-TR-82-12 NL

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TABLE B-1

HOURLY NOISE LEVELS (dB) AT HOMESTEAD AFB

September 21								
Hour	Site 1	Site 2	Site 3	Operation	Site 1	Site 2	Site 3	Operation
1	54.8							
2	53.4							
3	51.5							
4	52.5							
5	56.5							
6	52.4							
7	54.4							
8	47.0							
9	57.9							
10	75.0	59.1						
11	78.3	70.6						
12	80.4	67.5						
13	84.2	74.0						
14	61.8	72.3						
15	77.1	67.4						
16	81.4	70.1						
17	80.1	72.5						
18	75.1	65.0						
19	78.7	67.4						
20	71.5	67.9						
21	79.2	71.1						
22	72.8	69.1						
23	71.3	67.1						
24	53.4	45.2						
DNL	76.8	69.0						
CNEL	77.6	70.1						

TABLE B-2

WEATHER AT HOMESTEAD AFB

	Sep 10		Sep 11		Sep 12		Sep 13		Sep 14		Sep 15		Sep 16	
Hour	°F	%	°F	%	°F	%	°F	%	°F	%	°F	%	°F	%
1	82	79	79	88	81	79	79	88	75	94	82	82	81	79
2	82	79	79	83	81	79	80	83	78	88	80	88	81	77
3	82	79	80	85	77	91	76	88	76	94	80	88	80	79
4	81	82	80	85	77	88	77	85	76	94	80	88	80	79
5	81	82	81	85	76	90	79	83	76	94	77	91	80	79
6	81	82	78	88	78	90	78	88	75	94	77	91	80	79
7	81	82	79	85	79	88	79	85	75	94	77	91	80	79
8	81	82	80	85	78	90	80	82	74	94	79	84	81	77
9	82	79	80	85	82	82	81	79	76	88	81	82	82	75
10	82	79	83	72	83	76	82	79	80	82	83	77	84	69
11	83	77	85	72	83	77	84	75	82	80	84	77	84	69
12	84	75	85	72	85	72	84	75	79	82	84	77	84	69
13	84	75	89	72	85	72	85	72	82	77	85	72	85	70
14	84	75	85	72	85	70	84	72	83	77	85	72	85	70
15	84	75	85	72	85	70	85	75	83	74	84	72	86	68
16	84	75	86	70	83	74	84	75	83	74	83	74	85	69
17	83	77	85	72	83	74	83	77	83	74	84	72	84	72
18	82	79	84	75	83	74	83	74	82	77	83	74	84	72
19	82	79	83	74	82	77	82	77	82	77	79	82	83	74
20	82	79	82	77	81	79	81	79	82	75	78	76	82	76
21	82	79	82	77	80	82	80	82	82	77	79	82	82	76
22	82	79	82	79	80	82	81	79	81	82	80	79	82	76
23	81	82	77	85	79	85	78	82	81	85	80	79	82	76
24	80	85	81	79	79	85	76	91	81	82	80	79	81	79
Ave	82	79	82	79	81	80	81	80	79	84	81	80	NA	
Ave (Ops)	83	78	83	76	83	76	83	77	82	78	82	77	NA	

TABLE B-2

WEATHER AT HOMESTEAD AFB

Hour	Sep 17 °F	Sep 17 %	Sep 18 °F	Sep 18 %	Sep 19 °F	Sep 19 %	Sep 20 °F	Sep 20 %	Sep [illegible] °F	Sep [illegible] %			BUSY DAY AVE °F	BUSY DAY AVE %
1	81	79	81	74	80	77	80	77	[illegible]	[illegible]				
2	81	79	76	85	81	74	[illegible]	74	[illegible]	[illegible]				
3	81	79	79	85	80	77	80	77	81	82				
4	80	82	79	85	80	77	80	77	81	82				
5	80	82	79	85	80	77	80	77	81	82				
6	80	82	80	82	80	77	80	77	81	82				
7	80	82	80	82	80	77	80	77	81	82				
8	81	79	80	82	80	77	81	74	81	82				
9	83	74	82	77	82	72	82	72	83	77				
10	84	72	84	72	83	70	83	70	83	77				
11	84	72	84	72	84	67	84	68	84	74				
12	85	70	85	70	85	65	85	68	86	70				
13	85	70	86	68	85	65	85	68	87	68				
14	86	67	86	68	85	65	85	70	86	68				
15	84	72	85	68	85	68	85	68	85	72				
16	85	70	84	70	84	70	85	70	85	70				
17	84	72	85	68	84	70	84	72	84	74				
18	83	74	84	70	83	70	80	82	83	77				
19	82	77	82	75	82	72	81	80	83	77				
20	81	79	81	75	81	74	82	75	82	79				
21	82	77	81	75	81	74	81	77	81	82				
22	82	77	81	75	81	74	82	75	81	82				
23	77	82	81	74	81	74	79	82	81	82				
24	72	88	81	74	80	77	80	79	81	82				
Ave	82	77	82	75	82	73	82	74	83	78			82	78
Ave (Ops)	84	73	84	71	83	70	83	73	84	75			83	75

TABLE B-3

OPERATIONS LOGGED BY BASE OPERATIONS
AT HOMESTEAD AFB FL

Base Operations ID	PA	SA	TA	VI	PSG	ILS	ARA	VA
NOISEMAP Fit Tracks	05E1	05J1*	05F1	05G1*	05E1**	05E1	05E1	05G1
Sept 11	28	18	10	24	16	0	4	2
12	Aircraft	Did	Takeoff	Operations	Over	Microphone	Locations	
13	Aircraft	Did	Takeoff	Operations	Over	Microphone	Locations	
14	49	8	6	15	3	0	0	0
Sat 15	6	3	1	0	1	3	0	0
Sun 16	0	0	0	0	0	0	0	0
17	25	1	1	10	9	4	1	0
18	25	9	0	20	3	1	1	1
19	50	1	2	22	6	0	0	1
20	53	1	3	14	2	0	0	1
21	38	8	0	19	0	0	0	0
Total	274	49	23	124	40	8	6	5
Av Busy Day (9 Days)	36.44	5.44	2.56	14.33	Added to PA	Added to PA	Added to PA	Added to VI
NOISEMAP	22.42	18.38	4.43	25.71				

* NOISEMAP coded for pitch-out approach
** Slight variation of this flight track

TABLE B-4

F-4 AIRCRAFT PARAMETERS FROM STANDARD EVALUATION AT HOMESTEAD AFB FL

F-4 Parameters	Stan-Eval Site 1	NOISEMAP Input Site 1	Stan-Eval Site 2	NOISEMAP Input Site 2
% RPM	84% - 85%	87%	83% - 88%	87%
Airspeed	160 Kts	190 Kts	230 - 160 Kts	190 Kts
Altitude	500 ft	536 ft	1200 ft	1196 ft

TABLE B-5

SLANT DISTANCE TO FLIGHT TRACK AT HOMESTEAD AFB FL (In Feet)

	PA	SA	TA	ARA	VI	ILS	PSG
Site 1 Number of Samples	12	2	0	2	0	3	3
Average Slant Dist.	616 ft	652 ft		683 ft		575 ft	623 ft
Standard Deviation	±81	±16		±44		±98	±24
NOISEMAP Slant Dist.	536 ft	493 ft		536 ft		536 ft	536 ft
Site 2 Number of Samples	28	4	5	0	18	0	6
Average Slant Dist.	1306ft	1299ft	2072ft		1649ft		1462ft
Standard Deviation	±135	±406	±420		±265		±365
NOISEMAP Slant Dist.	1196ft	2000ft	2356ft		4357ft		1196ft

APPENDIX C

RANK ORDERING OF DNL CONTRIBUTORS AT A SITE FROM THE NOISECHECK PROCEDURES REPORT

DETERMINING MAJOR CONTRIBUTORS TO NOISEMAP DNL VALUES AT SPECIFIC SITES

NOISECHECK procedures rely on limited analysis of the aircraft noise information used by NOISEMAP to (1) predict the SEL at a point for comparison with measurements at that point and (2) determine the operations that contribute significantly to exposure at a point. This procedure requires accurate reconstruction of aircraft flight profiles from NOISEMAP chronicles to estimate NOISEFILE SEL values.

NOISEFILE SEL VALUES

Nominal SEL values for most military aircraft have been determined as a function of slant distance. The compilation of these data is called NOISEFILE. The data are available as computer tape files* and in Air Force Report AMRL TR-73-110, "Community Noise Exposure Resulting from Aircraft Operations: Acoustic Data on Military Aircraft" (1977). This report presents noise level vs distance data for takeoff power, cruise power, and approach power for each aircraft. Additional listings are presented for special power settings, such as afterburner and water injection. The report also presents an SEL adjustment for power settings and speeds that are not identical to the nominal values. **Note: This report, AFAMRL-TR-73-110 was published before the sound duration algorithm was changed from 10 log (D_1/D_2 to 6 log (D_1/D_2). The corrections to be applied to the SEL values are in an errata sheet that was published later.**

NOISEMAP AIRCRAFT OPERATIONAL PARAMETERS – GENERAL

Operational input information describing each individual aircraft mission is listed in the NOISEMAP chronicles and DATASCREEN summaries. The number of operations for each is summarized, but other parameters appear in the chronicles in the order in which the input data package was assembled. The parameters used to reconstruct NOISEMAP SEL values are:

- Flight tracks
- Altitude profile
- Delta SEL.

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*Contact the Air Force Aerospace Medical Research Laboratory, Biodynamic Environment Branch, Wright-Patterson Air Force Base, Ohio 45433.

DETERMINATION OF SELs AT A SITE

Two types of worksheets are used to determine SELs at a site. Worksheet 7 provides a summary of NOISEFILE data. Worksheet 8 consolidates the information for a particular aircraft and operation (e.g., KC-135A, pattern) and yields the SELs at sites of interest.

STEP-BY-STEP ESTIMATION OF NOISEFILE SEL VALUES

I. Use Worksheet 7 to list SEL data from Air Force Report AMRL TR-73-110 that is pertinent to each aircraft and mission. (See filled-in example in Figure C-1.)

   A. Enter operations type for the aircraft tabulated at top of table (e.g., operation/power settings: TAKEOFF in Figure C-1).

   B. Enter aircraft type in first row of table. (There may be multiple entries because of different varieties of takeoff procedures, for example.)

   C. Enter the pertinent aircraft code (ACC) and operations code (OPC) in Row 2 (e.g., 026/102 in second column of Figure C-1).

   D. Enter the corresponding power setting for the operations in percent, engine rpm, and/or exhaust pressure rating (EPR) in Row 3 (e.g., 96%/2.85 in second column of Figure C-1).

   E. Enter the corresponding airspeed (knots) in Row 4 (e.g., 200).

   F. Enter the SEL (dB) tabulation as a function of the slant distance tabulated with the left-hand column. Note: Summaries of both air-to-ground and ground-to-ground are required.

II. Complete a Worksheet 8 to include altitudes, lateral distances, NOISEFILE SELs, Delta-SEL profiles, and numbers of operations for each aircraft in the NOISEMAP chronicle that could affect the measurement sites.

Measurement Program__________
Sheet_____ of _______

Engineer___________________

Date ___________________

Air-To-Ground Propagation, Operation/Power Setting: Takeoff

SlntDist(ft)	KC135A	KC135A	B52G	A-37	T-37	T-38	T-38	T-39	C-130A	
A/C Type	KC135A	KC135A	B52G	A-37	T-37	T-38	T-38	T-39	C-130A	
ACC/OPC	026/102	026/103	043/103	504/103	034/103	033/101	033/103	033/103	006/103	
RPM/EPR	96/3.55	96/3.45	94/3.37	100	99	100	100	100	[illegible]	
Knots	200	200	170	300	170	300	300	180	170	
200	128.6	126.9	129.9	115.2	107.2	123.8	115.1	112.4	99.3	
250	127.1	125.6	128.6	113.9	105.0	122.0	113.9	111.1	97.2	
315	125.6	124.2	127.4	112.7	104.8	120.1	112.6	109.9	96.1	
400	124.2	122.8	126.1	111.3	103.6	118.3	111.3	108.6	94.9	
500	122.7	121.4	124.7	110.0	102.2	116.4	109.9	107.3	93.7	
630	121.2	120.0	123.3	108.5	100.9	114.6	108.5	105.9	92.4	
800	119.8	118.5	121.9	107.0	99.4	112.9	107.0	104.4	91.1	
1000	118.2	117.0	120.4	105.4	97.9	111.2	105.4	102.9	89.8	
1250	116.6	115.5	118.8	103.7	96.3	109.5	103.6	101.3	88.4	
1600	115.0	113.8	117.1	101.9	94.6	107.8	101.8	99.6	86.9	
2000	113.2	112.1	115.3	99.9	92.8	106.0	99.9	97.8	85.4	
2500	111.4	110.3	113.4	97.8	90.9	104.0	97.8	95.8	83.8	
3150	109.4	108.4	111.4	95.6	88.9	102.0	95.6	93.8	82.1	
4000	107.3	106.4	109.3	93.2	86.7	99.9	93.2	91.6	80.4	
5000	105.0	104.2	107.0	90.6	84.4	97.6	90.6	89.3	79.5	
6300	102.6	101.9	104.5	87.9	81.9	95.2	87.9	86.9	76.5	
8000	100.0	99.4	101.9	84.9	79.2	92.5	85.0	84.2	74.3	
10000	97.2	96.7	99.1	81.8	76.2	89.6	81.8	81.4	72.1	
12500	94.1	93.8	96.0	78.4	73.0	86.5	78.4	78.3	69.8	
16000	90.9	90.7	92.8	74.7	69.6	83.2	74.8	75.1	67.4	
20000	87.4	87.3	89.2	70.9	65.7	79.6	71.0	71.6	65.1	
25000	83.6	83.7	85.4	66.8	61.6	75.8	66.9	67.0	62.7	

Ground-To-Ground Propagation, Operation/Power Setting:

SlntDist.(ft)	KC135	KC135	B52G	A-37	T-37	T-38	T-38	T-39	C-130A	
A/C Type	KC135	KC135	B52G	A-37	T-37	T-38	T-38	T-39	C-130A	
ACC/OPC	026/102	026/103	043/103	504/103	034/103	033/101	033/103	033/103	006/105	
RPM/EPR	96/3.05	96/3.45	94/3.37	100	99	100	100	100	16800/970	
Knots	200	200	170	300	170	300	300	180	170	
200	123.6	121.9	124.9	110.2	102.2	118.8	110.1	107.4	93.3	
250	122.1	120.6	123.6	108.9	101.0	117.0	108.9	106.1	92.2	
315	120.6	119.2	122,4	107.7	99.8	115.1	107.6	104.9	91.1	
400	119.1	117.8	121.1	106.3	98.6	113.3	106.3	103.6	89.9	
500	117.7	116.4	119.7	105.0	97.2	111.4	104.9	102.2	88.7	
630	116.2	114.9	118.3	103.5	95.9	109.6	103.5	103.8	87.4	
800	114.6	113.5	116.8	102.0	94.4	107.9	102.0	99.4	86.1	
1000	113.1	111.9	115.3	100.4	92.9	106.2	100.3	97.8	84.7	
1250	111.3	110.3	113.7	98.7	91.2	104.4	98.6	96.2	83.2	
1600	109.5	108.5	112.0	95.8	89.5	102.6	96.8	94.4	81.6	
2000	107.6	106.7	110.1	94.8	87.6	160.7	94.8	92.6	79.9	
2500	105.3	104.5	108.1	92.7	85.5	98.6	92.6	90.4	77.9	
3150	102.6	102.1	105.8	90.3	83.2	96.2	90.2	88.8	75.6	
4000	99.4	99.2	103.1	87.6	80.4	93.5	87.6	85.3	73.0	
5000	95.7	95.8	100.0	84.5	77.2	90.2	84.4	82.1	70.0	
6300	91.5	92.0	96.5	81.0	73.6	86.6	81.0	78.5	66.7	
8000	87.8	88.7	93.3	77.6	70.3	83.3	77.5	75.2	63.7	
10000	83.7	85.0	89.7	73.7	66.6	79.6	73.7	71.4	60.4	
12500	79.1	80.8	85.7	69.5	62.5	75.4	69.5	67.3	56.8	
16000	73.9	76.2	81.3	64.7	57.9	70.7	64.7	62.7	52.7	
20000	68.3	71.1	76.4	59.4	52.7	65.4	59.4	57.5	48.5	
25000	62.3	65.4	70.8	53.4	46.9	59.5	53.5	51.8	44.2	

*Values listed do not reflect the NOISEFILE revision made in February 1980 for an improved model of sound duration as function of propagation distance.

FIG. C-1. EXAMPLE OF COMPLETED NOISEFILE SEL SUMMARY (59°F, 70% R.H.) (WORKSHEET 7).

A. Search chronicles for listings such as that shown below and, for each A/C type and operation, transfer the altitude profile (ALT PROF) and power profile (POW PROF) pertinent to each mission number. Transfer also the noise profile (NOISE PROF) appropriate to each site that is within the prescribed flight track limits.

Takeoff Descriptor Class No. – 261 A/C-KC-135A

Mission No. – 2

ALT PROF – 2612

POW PROF – 2612

TURN RAD – 6000.0 ft

SUBFLIGHT	NOISE PROF	TRACK LIMITS (FT)
1	262	0.0 to 27,000.0
2	263	27,000.0 to 1,000,000.0

B. From the Flight Operations Summary by Aircraft in the NOISEMAP chronicles, enter, for the aircraft selected, the total of day and night numbers of operations for the listed operation and mission number appropriate to the flight tracks near the measurement sites. For example, in the KC-135A summary from the NOISEMAP chronicle shown in Fig. C-2, the measurement sites nearer to Runway 14 are identified by mission number, and only numbers of approach operations near the measurement sites must be extracted because of this site/runway configuration. However, for sites nearer Runway 32, the daytime number of straight-out takeoffs for mission No. 2 would be 0.120 + 0.901 + 0.720 + ... = 2.581. Cursory examination of the chronicles of individual ALT and POW profiles pertinent to missions 31 through 35 (for the KC-135A) shows that their profiles (see Fig. C-2) are identical. Furthermore, description (by runway number) in the chronicles of the flight tracks for these missions indicates that all of these missions are pattern flights (see Fig. C-2). Thus, the sum (8.602) of the individual daytime operations is entered for KC-135A approach pattern missions 31 through 35 over sites closer to Runway 14.

KC-135A AIRCRAFT

NAME	NO	MSN	FLIGHT TRACK CODE	NUMBER OF OPERATIONS 0701-2200	NUMBER OF OPERATIONS 2201-0700	AIRCRAFT OPERATIONS
K135A 43	0261	0023	14B3	3.810	1.320	16.2 %
K135A C1	0261	0031	14CF	.461	.135	3.1 %
K135A C2	0261	0032	14CG	1.720	.270	6.3 %
K135A C3	0261	0033	14CH	3.440	.540	12.6 %
K135A C4	0261	0034	14CI	1.720	.270	6.3 %
K135A C5	0261	0035	14CJ	.861	.135	3.1 %
KC-135A	0261	0010	14E	3.180	.510	5.8 %
KC-135A	0261	0002	104	.120	.020	.2 %
KC-135A	0261	0003	104	.030	.005	.1 %
KC-135A	0261	0002	83	.901	.140	1.6 %
KC-135A	0261	0003	83	.210	.030	.4 %
KC-135A	0261	0002	88	.720	.110	1.3 %
KC-135A	0261	0003	88	.159	.030	.3 %
KC-135A	0261	0002	93	.120	.020	.2 %
KC-135A	0261	0003	93	.030	.005	.1 %
KC-135A	0261	0002	98	.720	.110	1.3 %
KC-135A	0261	0003	98	.159	.030	.3 %
TOTAL RUNWAY 14			TAKEOFFS	15.581	3.170	
			LANDINGS	15.592	3.180	
			OPERATIONS	37.523		59.3

(A) KC-135A SUMMARY NUMBER OF OPERATIONS

``` 
*** ALTITUDE PROFILE          NAME =   26131
       TRACK DIST         ALTITUDE
      -----------       -----------
            0. FT             0. FT
         4500. FT             0. FT
         9500. FT           200. FT
        23500. FT          1700. FT
       208300. FT          1700. FT
       247300. FT             0. FT

*** DELTA-SEL    PROFILE      NAME =   26131   K135   C1
       TRACK DIST       REL POWER (DB)
      -----------      --------------
            0. FT            6.9
        10000. FT            6.9
        18000. FT           -7.4
        19000. FT           -3.4
       207000. FT           -3.4
       208000. FT           -2.5
```

(B) ALTITUDE AND DELTA-SEL PROFILES

```
***    TAKE-OFFS     FLIGHT TRACK   32CF
                     PROCEED        31000. FT
                     TURN RIGHT     90.0 DEG   WITH    6000. FT   RADIUS
                     PROCEED        13800. FT
                     TURN RIGHT     90.0 DEG   WITH    6000. FT   RADIUS
                     PROCEED        91000. FT
                     TURN RIGHT     90.0 DEG   WITH    6000. FT   RADIUS
                     PROCEED        13800. FT
                     TURN RIGHT     90.0 DEG   WITH    6000. FT   RADIUS
                     PROCEED        60000. FT

                        FLIGHT OPERATIONS   -   TRACK 32CF
                     A/C NO   MISSION       -      0701-2200 2201-0700

***    K135A C          026       31                   .570      .090
```

(C) DESCRIPTIONS BY RUNWAY

FIG. C-2. EXAMPLE FROM NOISEMAP CHRONICLE (KC-135A).

C. Prepare a map showing runways, measurement sites, and flight tracks for missions.

D. Indicate altitudes for each mission.

E. Draw lines through each site and perpendicular to the flight track.

F. Enter down-range distance from start of takeoff roll, altitude, and perpendicular distance in Worksheet 9.

G. Using Eq. 1 in the supplement to Worksheet 8, calculate the slant distance from the perpendicular distances and the altitudes and enter in Worksheet 8.

Note: An altitude profile code of "ϕ" indicates that the profile is that of the glide slope for that runway and assumes that the aircraft is 50 ft above the runway at its threshold. The glide slope is listed in the chronicles within the runway description immediately following the runway number heading, as shown below.

```
                         --------------------------
***                          R U N W A Y    14
                         --------------------------
LENGTH 11829.4 FT, GL. SLOPE  2.50 DEG. HEADING 144.6 DEG
START (1539610.0.  674620.0).  END (1644320.0.  664260.0)
DISPLACEMENTS - TAKEOFF       0.0, LANDING       0.0
*************************************************************
```

H. Consolidate onto one sheet (for a given aircraft type) any grouping of ALT and POW profile numbers which, while different in number, are identical in actual profile.

I. From the NOISEMAP chronicle, enter the Delta-SEL profile data corresponding to the appropriate down-range distance.

J. Enter the Noise Profile pertinent to each site by referring to the track limits and corresponding noise profile in the chronicles.

K. Using Eq. 2 in the supplement to Worksheet 8, calculate the angle above the horizon, β. If angle β from any site is less than 7°, enter this in parentheses beside the Noise Profile Code for that site.

L. Calculate the NOISEFILE SEL and A/C SEL for each site, given the Noise Profile Delta-SEL on the sheet and the ACC/OPC Codes from Worksheet 7.

1. For 3-digit Noise Profile Codes, the 2 left-most digits of the Noise Profile Code are the 2 right-most digits of the ACC Code. The right-most digit of the Noise Profile Code is the right-most digit of the OPS Code. Enter the NOISEFILE SEL Summary (Worksheet 7), and select the appropriate column (from the ACC/OPC Code shown).

2. For Noise Profile Codes with more than 3 digits, the corresponding ACC and OPC Codes are similarly extracted; for nonobvious contractions or relationships, refer to the code numbers in Appendix B of Air Force Report AMRL TR-73-110. From the code numbers shown therein and their corresponding air speeds (knots) and Power Conditions (rpm/EPR), cross-check to the appropriate column already generated in the NOISEFILE SEL Summary, Worksheet 7.

3. Given the slant distance appropriate to each aircraft and site, find the NOISEFILE SEL from the appropriate column(s) by the formula:

$$SEL = SEL_{G-G} \quad \text{for } \beta \leq 4^{\circ}$$

$$SEL = SEL_{G-G} + \frac{\left(SEL_{A-G} - SEL_{G-G}\right) \times (\beta - 4)}{3} \quad \text{for } 4^{\circ} \leq \beta \leq 7^{\circ}$$

$$SEL = SEL_{A-G} \quad \text{for } \beta \geq 7^{\circ}$$

i. For interpolation at distance D_x between shorter distance D_1 listed and greater distance D_2 listed, use the formula:

$$SEL_x = SEL_1 - \left(SEL_1 - SEL_2\right) \frac{\mathrm{Log}(D_x/D_1)}{\mathrm{Log}(D_2/D_1)} .$$

ii. Tabulate on Worksheet 9 the NOISEFILE SEL values thus determined for each site, add the corresponding Delta-SEL corrections to yield the A/C SEL, and enter these also on Worksheet 8.

This concludes the procedure for estimating the SEL at a point from analysis of NOISEMAP and NOISEFILE data. This "NOISEFILE SEL" may be used three times during NOISECHECK: (1) to estimate the "partial DNL" from individual types of operations at a site so that the relative importance of various operations can be assessed during the planning phase (Worksheet 9) (2) to estimate the variance of NOISEMAP during data analysis (Worksheet 5); and (3) to seek out reasons why values of DNL from measurements differ from NOISEMAP values of DNL.

Step-by-Step Procedure to Determine the Significant Contributors to DNL at a Site

1. Complete headings for program, site, engineer, and date.

2. From Worksheet 8, transfer the following data for this site: aircraft, operation, mission number, aircraft SEL, and numbers of operations.

3. Using Eq. 1 in the supplement to Worksheet 9, calculate the effective number of operations for each operation and enter on Worksheet 9.

4. Using Eq. 2, calculate the partial DNL for each operation.

5. Rank order operations in terms of decreasing DNL.

6. Using Eq. 3, list "total DNL through rank" for each operation (i.e., for the operation ranked 2, this is $DNL_1 + DNL_2$, and for the operation ranked 3, this is $DNL_1 + DNL_2 + DNL_3$, etc.) until the total is within 0.3 dB of the NOISEMAP DNL for this site.

7. All operations contributing to this total should be considered significant contributors to the site DNL. SEL data should be obtained for these operations during NOISECHECK.

APPENDIX D

BLANK WORKSHEETS AND SUPPLEMENTAL EQUATIONS

Measurement Program_____ Sheet ___ of ___

Site Number _______________

Engineer _______________

Date _______________

WORKSHEET 1

Date	Day of Week	From Paper Tape		Bkgrnd. DNL (1)	DNL' (2)	Effective No. of Oper. (3)	No. Adj. (4)	Adj. DNL
		Day No.	Meas. DNL					

(1) From Eq. 1 or Other Information

(2) From Eq. 2

(3) From Tower Log Analysis

(4) Adjustment = $-10 \log \frac{\text{Effective No. of Oper.}}{\text{NOISEMAP Effective No. of Oper.}}$

Calculated	
Measurement Std. Deviation	Measurement DNL

FIG. D-1. CALCULATE DAILY DNL ADJUSTED FOR BACKGROUND AND NUMBER OF OPERATIONS (WORKSHEET 1).

SUPPLEMENT TO WORKSHEET 1

1. The background Day-Night-Level, DNL(BG), can be estimated from:

$$DNL(BG) = 10 \log \left\{ \left[(15 \text{ antilog } \overline{L}_{h_d}/10) + (90 \text{ antilog } \overline{L}_{h_n}/10) \right] /24 \right\},$$

where $\overline{L}_{h_d}$ is the energy average daytime hour without aircraft noise,

and $\overline{L}_{h_n}$ is the energy average nighttime hour without aircraft noise.

2. For each day

$$DNL' = 10 \log \left\{ \text{antilog } DNL/10 - \text{antilog } DNL(BG)/10 \right\}.$$

3. The energy average Day-Night Level, DNL(M) is:

$$DNL(M) = 10 \log \left[\left(\sum_{i=1}^{m} \text{antilog } DNL'/10 \right) /m \right],$$

where m is the number of adjusted daily DNLs on Worksheet 6.

4. The standard deviation for (antilog $\overline{DNL}$/10) is:

$$\sigma_M = \sqrt{\frac{1}{m_i - 1} \left\{ \sum_{i=1}^{m} \left[\text{antilog}(DNL'_i/10) \right]^2 - \left[\sum_{i=1}^{m} \text{antilog}(DNL'_i/10) \right]^2 /m \right\}}.$$

5. The confidence intervals about the $\overline{DNL}$ are:

$$c.i. = 10 \log \left[\text{antilog}(\overline{DNL}/10) \pm z_c \frac{\sigma_M}{\sqrt{m}} \right].$$

For a 90% confidence interval, $z_c = 1.645$; for a 95% confidence interval, $z_c = 1.960$.

WORKSHEET 2

Engineer ________________

Measurement Date ________________

Operation	Site ____		Site ____		Site ____		Site ____	
	SEL	Max.	SEL	Max.	SEL	Max.	SEL	Max.

FIG. D-2. NOISE LEVEL LOG (WORKSHEET 2).

Measurement Program ____ Sheet ____ of ____

Site Number ____________________

Engineer ____________________

Measurement Date ____________________

WORKSHEET 3

Runway	A/c	Oper.	No. of Meas., n_i	SEL_i	90% c.i. (+)	90% c.i. (-)	σ_i

FIG. D-3. SEL COMPUTATION SHEET (WORKSHEET 3).

SUPPLEMENT TO WORKSHEET 3

1. Energy average noise level of aircraft and operation i:

$$\overline{SEL}_i = 10 \log \left[\frac{1}{n_i} \sum_{k=1}^{n_i} \text{antilog } (SEL_k/10)\right].$$

2. Energy standard deviation for aircraft and operation i:

$$\sigma_i = \sqrt{\frac{1}{n_i-1} \left\{ \sum_{k=1}^{n_i} \left[\text{antilog}(SEL_k/10)\right]^2 - \left[\sum_{k=1}^{n_i} \text{antilog}(SEL_k/10)\right]^2 / n_i \right\}}.$$

3. Confidence interval (c.i.) for aircraft and operation i:

$$\text{c.i.} = 10 \log \left[\text{antilog } (\overline{SEL}_i/10) \pm z_c \frac{\sigma_i}{\sqrt{n_i}}\right].$$

For a 90% confidence interval, $z_c = 1.645$; for a 95% confidence interval, $z_c = 1.960$.

Measurement Program____ Sheet____ of____

Site Number	
Engineer	
Measurement Date	

WORKSHEET 4

Runway	A/C	Oper.	Adj. SEL_i	N_i	n_i	σ_i

From Equations in Supplement

DNL	
σ	
90% c.i. (+)	
90% c.i. (-)	

FIG. D-4. COMPUTED DNL AND CONFIDENCE INTERVAL FROM MEASURED SELs (WORKSHEET 4).

SUPPLEMENT TO WORKSHEET 4

1. DNL based on the adjusted energy average SELs:

$$DNL(S) = 10 \log \left[\sum_{i=1}^{n_j} N_i \text{ antilog } (\overline{SEL}_i/10) \right] - 49.4.$$

2. The standard deviation for antilog DNL(S)/10 is:

$$\sigma_s = \left(\sqrt{\sum_{i=1}^{n_j} N_i^2 \sigma_i^2} \right) \frac{1}{86,400}$$

3. The confidence intervals (c.i.) about the DNL are:

$$c.i. = 10 \log \left[\text{antilog } (DNL(S) / 10) \pm z_c \sqrt{\sum_{i=1}^{n} N_i^2 \sigma_i^2 / n} \right]$$

or

$$c.i. = 10 \log \left[\text{antilog } (DNL(S) / \text{-}10) \pm z_c \sigma_s / \sqrt{n} \right]$$

For a 90% confidence interval, $z_c = 1.645$; for a 95% confidence interval, $z_c = 1.960$.

(Note: The confidence intervals, expressed in dB, will not be equal.)

Measurement Program ____ Sheet ___ of ___

Site Number	
Engineer	
Date	

WORKSHEET 5

From Worksheet 9							From Chart Fig. 11	From Equation 1
Aircraft	Runway	Operation	Slant Distance	Elevation Angle	Aircraft SEL	Effective No. of Oper.	Variance	σ_i

NOISEMAP DNL	
Calculated σ	
90% c.i. (+)	
90% c.i. (-)	

FIG. D-5. CALCULATE THE NOISEMAP CONFIDENCE INTERVALS AND STANDARD DEVIATION (WORKSHEET 5).

SUPPLEMENT TO WORKSHEET 5

1. The estimated standard deviation associated with each operation for which an SEL is listed on Worksheet 5 is:

$$\sigma_i = N_i \left(\text{antilog } \left((SEL_i + \sqrt{\text{VARIANCE}})/10 \right) - \text{antilog } (SEL_i/10) \right)$$

2. The estimated standard deviation associated with antilog (DNL(C)/10) is:

$$\sigma_c = \frac{\sqrt{\sum_{i=1}^{\ell} \sigma_i^2}}{86{,}400} .$$

3. The estimated confidence intervals about the NOISEMAP computed DNL value are:

$$c.i. = 10 \log \left[\text{antilog}(DNL(C)/10) \pm z_c \sigma_c / \sqrt{\ell} \right] ,$$

where ℓ is the number of SELs listed on Worksheet 5.

For a 90% confidence interval $z_c = 1.645$; for a 95% confidence interval, $z_c = 1.960$.

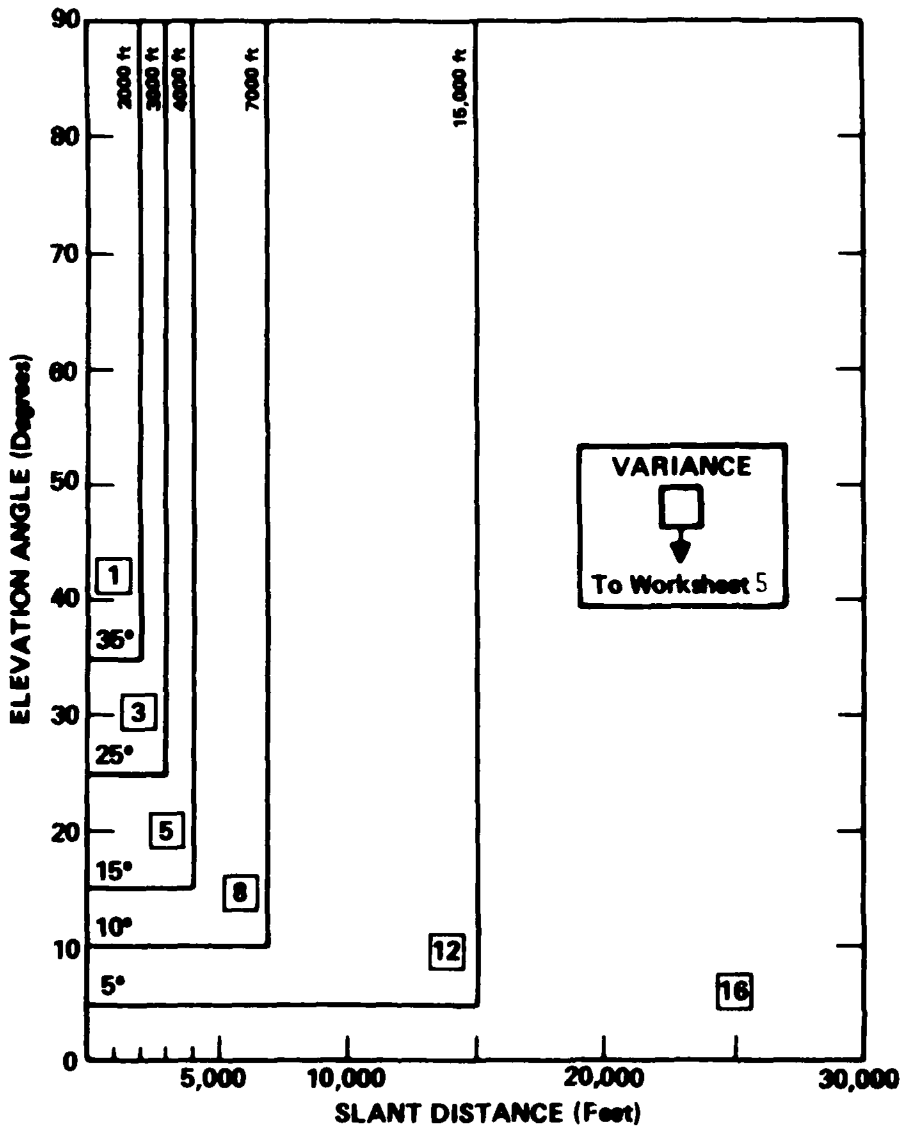

FIG. D-6. ESTIMATE OF NOISEMAP VARIANCE.

Measurement Program____ Sheet___ of___

File Number ________________
Engineer ________________
Date ________________

WORKSHEET 6

From Worksheet	or Worksheet	From Worksheet	From NOISEMAP
Measurement Standard Deviation	Measurement DNL	NOISEMAP Standard Deviation	NOISEMAP DNL
σ_S or σ_M	DNL(M) or DNL(S)	σ_t	DNL(C)

Calculated
Parameter Z

↓

From Table 1
Parameter p

↓

Calculated
Probability Equals 2 - 2p

This Value is the Probability that the Measurements and the NOISEMAP Predictions are Consistent.

(The Probability that they are not Consistent is 1 Minus this Value.)

FIG. D-7. CALCULATE THE PROBABILITY THAT THE DNL FROM MEASUREMENTS AND THE DNL FROM NOISEMAP ARE CONSISTENT (WORKSHEET 6).

SUPPLEMENT TO WORKSHEET 6

For the measured DNL, denoted by DNL(M), that is computed from daily values of DNL (Worksheet 6), use:

$$1. \quad z = \frac{|\text{antilog}(\text{DNL}(C)/10)-\text{antilog}(\text{DNL}(M)/10)|}{\sqrt{\sigma_C^2 + \sigma_M^2}} ,$$

or for synthesized DNL, denoted by DNL(S), that is computed from measured SELs (Worksheet 3), use:

$$2. \quad z = \frac{|\text{antilog}(\text{DNL}(M)/10)-\text{antilog}(\text{DNL}(S)/10|}{\sqrt{\sigma_C^2 + \sigma_S^2}} .$$

Measurement Program ________
Sheet____ of ________

WORKSHEET 7

Engineer____________________

Date ____________________

Air-To-Ground Propagation, Operation/Power Setting:

SlntDist.(ft)										
A/C Type										
ACC/OPC										
RPM/EPR										
Knots										
200										
250										
315										
400										
500										
630										
800										
1000										
1250										
1600										
2000										
2500										
3150										
4000										
5000										
6300										
8000										
10000										
12500										
16000										
20000										
25000										

Ground-To-Ground Propagation, Operation/Power Setting:

SlntDist.(ft)										
A/C Type										
ACC/OPC										
RPM/EPR										
Knots										
200										
250										
315										
400										
500										
630										
800										
1000										
1250										
1600										
2000										
2500										
3150										
4000										
5000										
6300										
8000										
10000										
12500										
16000										
20000										
25000										

FIG. D-8. NOISEFILE SEL SUMMARY (59°F, 70% R.H.) (WORKSHEET 7).

Measurement Program________Sheet __ of __

Site Number________________
Engineer________________
Date________________
Aircraft Type________________
Operation________________
Mission________________
Altitude Profile Code________________
Power Profile Code________________

WORKSHEET 8

From Map				From Chronicle	
	Distances (feet)				
Site	Altitude	Lateral Distance	Downrange Distance	Noise Profile	Δ SEL

Use Eq. 1 in Supplement

	From Worksheet 7	NOISEFILE SEL + Δ SEL
Slant Distance	NOISEFILE SEL	Aircraft SEL

Use on Worksheet 9 or for AIRCRAFT SEL from NOISEFILE

FIG. D-9. CALCULATION OF SLANT DISTANCE AND AIRCRAFT SEL AT SITES (WORKSHEET 8).

Supplement to Worksheet 8

1. $\text{Slant distance (ft)} = \sqrt{\text{perpendicular distance (ft)}^2 + \text{altitude (ft)}^2}$,

   where the lateral distance is the perpendicular distance from the measurement site to the point of closest approach on the flight track.

2. $\text{Angle } \beta \text{ in degrees} = \sin^{-1}\left(\frac{\text{altitude}}{\text{slant distance}}\right)$.

Measurement Program________Sheet __ of __

Site Number____________________

Engineer____________________

Date____________________

WORKSHEET 9

From Worksheet 8					
Aircraft	Operation	Mission	Aircraft SEL	Day Operations	Night Operations

Use Equations in Supplement

Calculated			
Effective Numbers of Operations	Partial DNL	Rank Number	Total DNL Through Rank

FIG. D-10. STEP-BY-STEP ESTIMATION OF THE RELATIVE IMPORTANCE OF OPERATIONS AT A SITE (WORKSHEET 9).

Supplement to Worksheet 9

1. $$\text{Effective number of operations} = \begin{pmatrix}\text{number of day}\\ \text{operations}\\ \text{(0700-2200)}\end{pmatrix} + 10\begin{pmatrix}\text{number of night}\\ \text{operations}\\ \text{(2200-0700)}\end{pmatrix}.$$

2. $$\text{Partial DNL} - \text{Aircraft SEL} + 10\log\begin{pmatrix}\text{Effective}\\ \text{number of}\\ \text{operations}\end{pmatrix} - 49.4.$$

3. $$\text{Total DNL through rank} = 10\log\left[\left(10^{DNL_1/10}\right) + \cdots + \left(10^{DNL_n/10}\right)\right],$$

where n is the rank number being calculated.

TABLE D-1

THE RELATIONSHIP OF PARAMETERS p AND z.

z_p ↓ / →	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

*U.S.Government Printing Office: 1982 — 559-007/6026

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5-8