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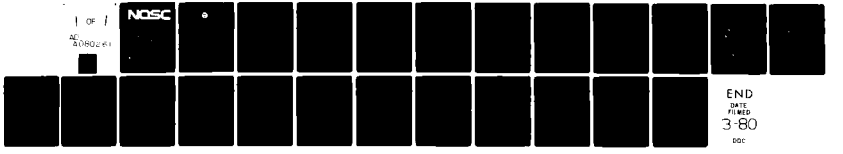

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AIRCRAFT NOISE MONITORING AT NAVAL TRAINING CENTER AND MARINE CORPS RECRUIT DEPOT, SAN DIEGO, CALIFORNIA, IN 1978 AND 1979

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R. G. Klumpp

15 September 1979

Prepared for
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Aircraft noise from Lindbergh Field was measured during 1978 and 1979 at selected locations within the Naval Training Center (NTC) and the Marine Corps Recruit Depot (MCRD) and compared with noise measured in 1972. The comparison showed that at two locations the noise level had increased and at one location it had decreased.

Noise contours based on the 1978–1979 measurements were generated for NTC and MCRD using a NOISEMAP computer program. Contours were then projected to 1985 by using assumptions concerning aircraft mix and numbers of operations. The projected contours show that if compliance with existing FAA noise regulations is obtained the noise impact of Lindbergh Field on NTC and MCRD will be reduced substantially.

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SUMMARY

Aircraft noise from Lindbergh Field was measured during 1978 and 1979 at selected locations within the Naval Training Center (NTC) and the Marine Corps Recruit Depot (MCRD) and compared with noise measured in 1972. The comparison showed that at two locations the noise level had increased and at one location it had decreased.

Noise contours based on the 1978-1979 measurements were generated for NTC and MCRD using a NOISEMAP computer program. Contours were then projected to 1985 by using assumptions concerning aircraft mix and numbers of operations. The projected contours show that if compliance with existing FAA noise regulations is obtained the noise impact of Lindbergh Field on NTC and MCRD will be reduced substantially.

CONTENTS

INTRODUCTION

The Naval Ocean Systems Center (NOSC) was requested by Western Division, Naval Facilities Engineering Command, to monitor aircraft noise from San Diego International Airport (Lindbergh Field) at the Marine Corps Recruit Depot (MCRD) and Naval Training Center (NTC), San Diego, California. Measurements were to include a 13-day record of noise levels at two buildings at NTC and one building at MCRD for comparison with measurements made by Bolt Beranek and Newman (BBN) in 1972 at the same sites. In addition, current and projected 1985 Community Noise Equivalent Level (CNEL) contours were to be generated for the NTC and MCRD property. CNEL is a 24-hour average sound level in which evening and night sound levels are counted more heavily. (See appendix B for a more exact definition.)

Data previously obtained by NOSC during the period July through September 1978 were included with the data for 1979. The 1978 monitoring did not include all sites specified in the request for the 1979 monitoring.

Approximately 1 week after noise monitoring was started in 1979, a strike grounded all United Airlines aircraft. Instruments were left installed in hope of a quick settlement of the strike. However, the long duration of the strike delayed completion of the monitoring for more than 2 months. Noise levels listed in this report are for those periods in which United Airlines was in full operational status.

RESULTS

This section will be divided into four parts:

- o Previous Data: Noise levels in 1972 as per BBN letter report of 2 March 1972.
- o Current Data: Noise levels in 1978 and 1979 as measured by NOSC.
- o Comparison of Previous and Current Data.
- o Noise Contours: Noise contours at NTC and MCRD, 1979 (based on measurements), and noise contours at NTC and MCRD, 1985 (based on projections).

Details on measurement methods and data are given in appendices A through D.

PREVIOUS DATA

These CNEL measurements (table 1) were obtained at NTC and MCRD in 1972. The data are from table 1 of the 1972 BBN report (reference 1).*

Table 1. CNEL measurements from NTC and MCRD in 1972 (reference 1).

Location	Number of CNELs Obtained	Monitoring Period	CNEL (Arithmetic Mean), dB
Building 186 (NTC)	11	19-31 January 1972	80.3
Building 91 (NTC)	7	19-31 January 1972	73.0
Building 570 (MCRD)	7	19-31 January 1972	79.7

CURRENT DATA

These CNEL measurements (table 2) were obtained at NTC and MCRD in 1978 and 1979. Measurements were made by NOSC.

*References are listed in appendix E.

Table 2. CNEL measurements from NTC and MCRD in 1978 and 1979.

Location	Number of CNELs Obtained	Monitoring Period	CNEL (Energy Average), dB
Building 186 (NTC)	45	25 July--23 Sep 1978	84.1
	8	23-30 March 1979	84.0
	14	8-21 June 1979	83.3
Total:	67	Average:	83.9
Building 91 (NTC)	7	24-30 March 1979	75.9
	14	8-21 June 1979	75.1
Total:	21	Average:	75.4
Building 570 (MCRD)	7	24-30 March 1979	79.6
	9	8-21 June 1979	77.6
Total:	16	Average:	78.6
Building 596 (MCRD)	28	25 July--11 Sep 1978	78.2
Building 312 (MCRD)	15	30 July--19 Sep 1978	82.7
	7	24-30 March 1979	82.4
	14	8-21 June 1979	82.7
Total:	36	Average:	82.6
Building 251 (NTC)	19	26 July--20 Sep 1978	70.5
	7	24-30 March 1979	71.5
Total:	26	Average:	70.8
Building 328 (NTC)	3	24-30 March 1979	66.8

COMPARISON OF NOISE LEVELS, 1972 AND 1979

Before a meaningful comparison could be made, the average CNELs from 1972 and 1978-1979 had to be converted to a common base. The two sets of measurements were taken at different times of the year and different procedures for averaging were used to obtain mean levels.

The California Aircraft Noise Standards require the CNEL contours to be based on a 12-month average CNEL. Both the 1972 and 1978-1979 data can be adjusted to reflect an average CNEL for the preceding 12 months. This adjustment is based on the total number of operations for the year and a determination of whether the number of operations during the period sampled was representative of the year. For the BBN 1972 measurements the January period of measurement had 190 flight operations per day, whereas the average number of operations per day for the 12-month period of February 1971 to January 1972 was 204. Therefore the adjustment to produce a 12-month average CNEL would be the addition of 0.3 dB. For the NOSC CNELs, the time of year and duration of measurement differed from building to building. Corrections to adjust the obtained CNELs to the 12-month period of July 1978 to June 30, 1979, were 0.0 dB for Building 186, -0.3 dB for Building 91 and -0.2 dB for Building 570.

The three mean CNELs listed in table 1 are arithmetic means of the individual (daily) CNELs. The California Aircraft Noise Standards state that energy averaging is to be used to obtain an average CNEL. Recalculation shows that 0.2 dB should be added to the 1972 CNEL to obtain the average CNEL.

Table 3 shows the adjusted CNELs at the three sites and the change in CNEL between the two measurement periods.

Table 3. Comparison of adjusted 1972 and 1978-1979 CNELs at NTC and MCRD.

Time Period	CNEL, dB		
	Building 186 (NTC)	Building 91 (NTC)	Building 570 (MCRD)
1978-1979	83.9	75.1	78.4
1971-1972	80.8	73.5	80.2
Change	+3.1	+1.6	-1.8

If factors such as passenger and fuel loads, mix of aircraft types, takeoff and landing paths remain constant, the change in average CNEL would depend primarily on the change in number of aircraft operations. From 1972 to 1979 the number of aircraft operations in a 12-month period increased from approximately 74,000 to approximately 93,000. This increase of 19,000 operations can be expected to increase the noise level by 1 dB. However, increases of 3.1 dB at Building 186 and 1.6 dB at Building 91 and the decrease of 1.8 dB at Building 570 suggest that the departure flight path has changed from the 1972 period to the 1979 period.

Because the BBN report of 1972 does not indicate the flight path, no flight path comparison was made with the NOSC 1979 measurements which show the mean flight path over NTC and MCRD to be 275.2 deg (see appendix D).

For all monitor periods, good agreement (maximum difference of 1 dB) was noted between levels at NTC Building 186 and the close-by Lindbergh noise monitor 07 operated by the San Diego Port District.

NOISE CONTOURS

CNEL contours were provided by R.E. Glass of the Aircraft Environmental Support Office (AESO), NARF, NAS, North Island, from information obtained by NOSC during the monitoring period. AESO used the NOISEMAP computer program to generate the CNEL contours. CNELs taken by NOSC during the monitoring periods were used to establish the contour validity. Once this validity was insured, the contour based on a 12-month period was generated. The CNEL contour map for the 12-month period ending June 30, 1979, is in figure 1.

Projected Lindbergh Field operations and aircraft mix for use in generating 1985 contours were based on information in table 3c of reference 2. Calculations based on table 3c and actual Lindbergh operations in 1978 show a projected increase of aircraft operations to 105,400 in 1985. This information was entered into the NOISEMAP program using the initial valid contour as a base. The assumption was made that full compliance with Part 36 of the Federal Aviation Regulations would be achieved, including full engine retrofitting of present aircraft. The CNEL contour map projected for 1985 is shown in figure 2.

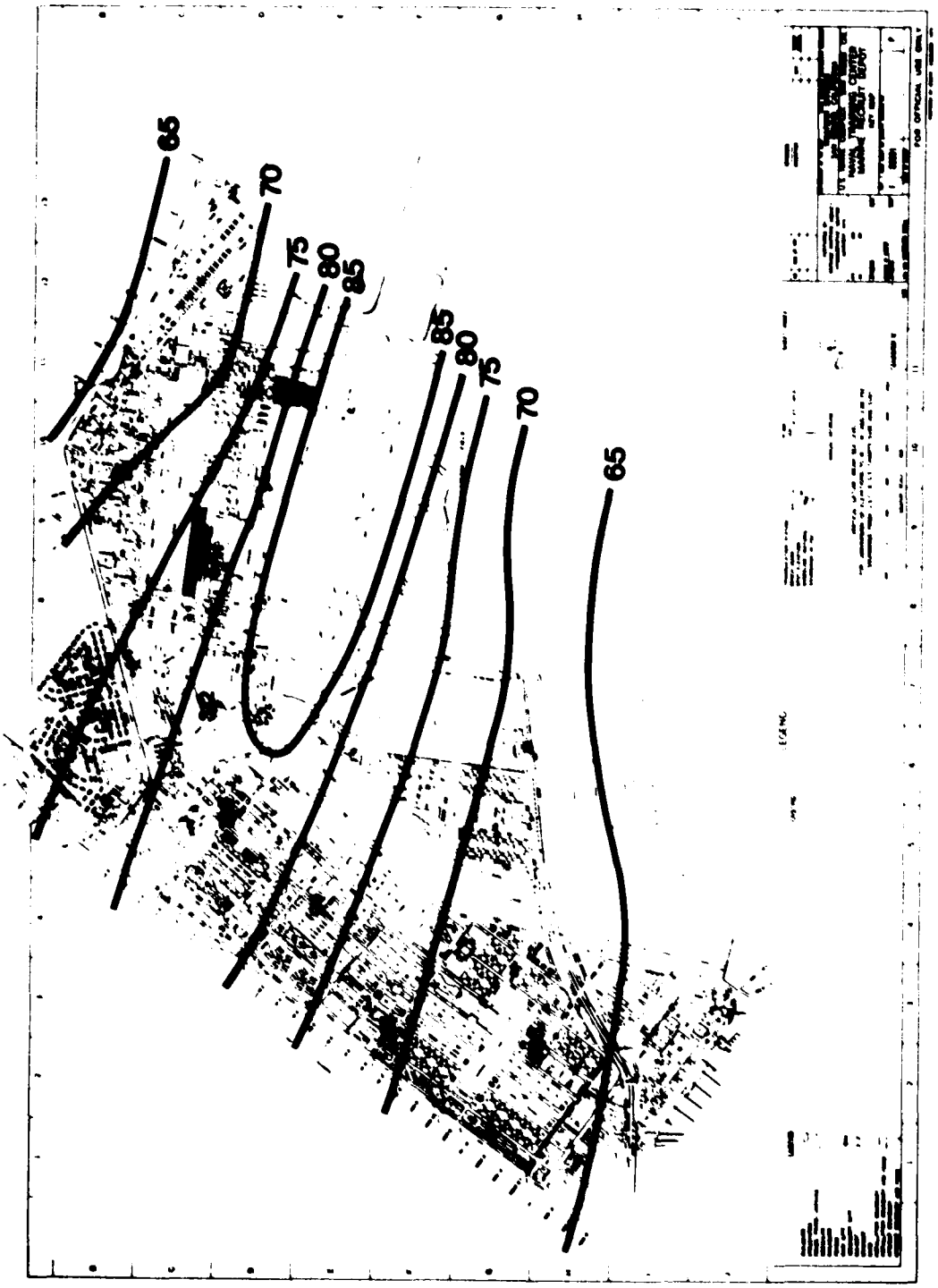

Figure 1. NOSC-estimated CNEL contours for 12-month period ending , June 1979.

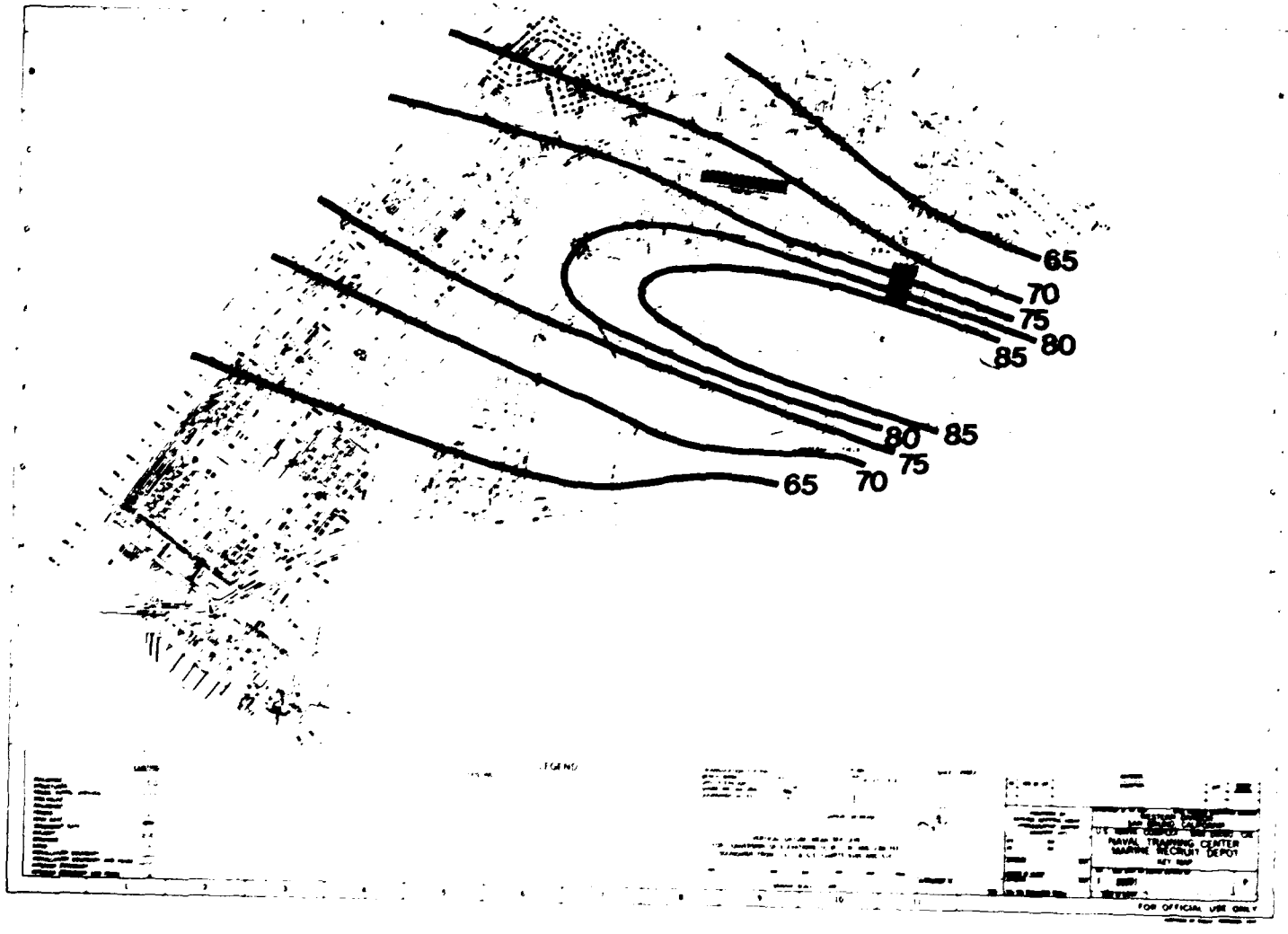

Figure 2. NOSC-estimated CNEL contours for 1985.

CONCLUSIONS

The comparison of 1972 and 1978-1979 CNELs taken at the same buildings shows the greatest change to be at Building 186 at NTC (3.1 dB). One possible cause of this increase is the increase in flight operations at Lindbergh Field. This would account for only 1 dB of the increase, however. The most likely cause of the remaining amount of increase is a southerly shift in the flight pattern. This is borne out by the increase in CNEL observed to the south at NTC Building 91 and the decrease in level at MCRD Building 570 located to the north of Runway 27.

A comparison of the 1972 contours with the contours for the 12-month period ending June 30, 1979, illustrates the changes observed at the monitor sites. All contours have widened, shifted to the south, and extended farther along the flight path. For example, the 80-dB CNEL contour which passed near Building 186 in 1972 now extends past the NTC boundary at Rosecrans Street.

The contours for 1985 show that, even with the increased number of aircraft operations, compliance with Part 36 of the Federal Aviation Regulations will substantially decrease the noise impact of Lindbergh Field operations upon NTC and MCRD. The 30-dB CNEL contour would retreat from the 1979 location beyond Rosecrans Street to a position in the estuary which separates NTC and MCRD.

APPENDIX A. NOISE MONITOR LOCATIONS

Portable noise monitors were installed in 1979 at four sites at the Naval Training Center (NTC) and two sites at the Marine Corps Recruit Depot (MCRD). Three of the sites duplicated those used by Bolt Beranek and Newman for their noise survey in 1972 -- Building 186 (NTC), Building 91 (NTC), and Building 570 (MCRD). The other sites were chosen to examine noise levels at locations approximately on the CNEL contours of 65, 70 and 80 dB: Building 328 (NTC), Building 251 (NTC), and Building 312 (MCRD), respectively. During the period of July through September 1978, measurements were made at Building 186, Building 251, Building 312, and Building 596 (MCRD). Building 596 is near Building 570 (MCRD). These 1978 measurements were made by personnel of the Aircraft Environmental Support Office under the direction of Robert W. Young of NOSC. Available detailed location information is presented in table A1.

The 1979 installations were done on March 22-23, 1979. The periods of operation and types of monitors installed are listed in table A2.

Acoustic calibrations were performed at least once a week with a General Radio Model 1562A sound-level calibrator. Corrections were performed on the CNELs, if indicated by the calibration data.

Table A1. Detailed information on 1979 NOSC noise monitoring locations.

Area	Description
Building 186 (NTC)	Single-story building. Microphone located near northeastern side of building: 117 ft from southeastern end of building and 10 ft above roof.
Building 91 (NTC)	Four-story building. Microphone located 10 ft above roof: 64 ft from northwest end of northerly wing and 16-1/2 ft from northeast edge of building.
Building 570 (MCRD)	Three-story building. Microphone located on southern wing: 43 ft from west end, centered on roof. Microphone 8 ft above roof.
Building 328 (NTC)	Two-story building. Microphone located 8 ft above roof on northwestern corner of second story of building.
Building 251 (NTC)	Two-story building. Microphone located on northeastern end of second story 10 ft above roof.
Building 312 (MCRD)	One-story building. Microphone located 10 ft above roof on southeast wing: 47 ft from northeast end of wing and 4 ft from roof edge.

Table A2. Period of operation and type of monitor installed at sites.

Location	Period of Operation	Monitor Type
Building 186 (NTC)	7/25/78 - 9/23/78	BBN 614, Configuration 40006
	3/22/79 - 6/22/79	BBN 614, Configuration 40006
	4/12/79 - 6/22/79	Deltec 8000
Building 91 (NTC)	3/23/79 - 6/22/79	BBN 614, Configuration 40006
Building 570 (MCRD)	3/23/79 - 6/22/79	Deltec 8000
Building 328 (NTC)	3/22/79 - 4/12/79	Deltec 8000
Building 251 (NTC)	7/26/78 - 9/20/78	Digital Acoustics DA 603A
	3/23/79 - 5/23/79	Deltec 8000
Building 312 (MCRD)	7/30/78 - 9/18/78	Digital Acoustics DA 603A
	3/23/79 - 6/22/79	BBN 614, Configuration 40006
Building 596 (MCRD)	7/25/78 - 9/11/78	BBN 614, Configuration 40006

APPENDIX B. COMMUNITY NOISE EQUIVALENT LEVEL

The California Aircraft Noise Standards (reference 3) define the methods which are to be used to obtain Community Noise Equivalent Level (CNEL). The CNEL is calculated from the energy-averaged, 24 hourly average noise levels (HNL) in a single day. The hourly average levels for the period 0700-1900 are unweighted; the hourly average levels for the period 1900-2200 are weighted by the addition 5 dB; and the hourly average levels for the period 2200-0700 are weighted by the addition of 10 dB. These weightings are to account for the increased annoyance of noise events in the evening and night hours.

Tables B1 and B2 list the CNELs obtained at the monitor sites during 1978 and 1979. The energy-averaged CNEL for the CNELs listed is shown at the bottom of each period of measurement with the number of CNELs obtained during the period.

Table B1. 1978 CNEL measurements at NOSC monitoring sites.

Date	CNEL, dB			
	Building 186 (NTC)	Building 596 (MCRD)	Building 312 (MCRD)	Building 251 (NTC)
July 25	-	-		
July 26	84.9	79.0		-
July 27	-	-		70.5
July 28	-	-		65.2
July 29	83.5	76.8		69.1
July 30	83.0	78.7	-	-
July 31	83.5	77.6	-	-
August 1	84.0	79.4	82.9	-
August 2	83.9	78.1	-	70.7
August 3	85.0	79.0	-	71.2
August 4	85.1	78.9	83.2	70.9
August 5	83.8	78.2	-	-
August 6	82.7	78.5	-	-
August 7	84.9	-	-	-
August 8	84.6	-	-	-
August 9	84.1	-	-	69.6
August 10	84.6	-	83.0	-
August 11	84.7	-	83.1	-
August 12	83.3	80.3	82.3	70.0
August 13	84.1	79.6	-	-
August 14	83.5	78.3	-	-
August 15	84.2	79.0	83.1	71.0
August 16	83.1	78.0	-	-
August 17	84.8	-	-	-
August 18	84.6	-	-	-
August 19	84.3	78.0	-	-
August 20	83.4	78.9	-	-
August 21	85.0	78.1	-	-
August 22	83.3	78.8	84.3	-
August 23	84.2	77.0	-	70.7
August 24	85.0	77.7	-	-
August 25	85.8	-	82.7	71.3
August 26	85.3	-	-	-

Table B1. 1978 CNEL measurements at NOSC monitoring sites. Continued.

Date	CNEL, dB			
	Building 186 (NTC)	Building 596 (MCRD)	Building 312 (MCRD)	Building 251 (NTC)
August 27	83.5	-	-	-
August 28	84.4	-	-	-
August 29	83.9	76.8	81.9	69.5
August 30	84.3	76.8	80.7	-
August 31	84.9	76.9	-	-
September 1	85.5	77.7	-	-
September 2	82.1	77.2	-	-
September 3	83.0	77.1	-	-
September 4	85.6	76.4	-	-
September 5	-	-	-	-
September 6	-	-	-	-
September 7	-	-	82.3	71.1
September 8	-	-	-	71.0
September 9	82.5	-	83.4	70.0
September 10	83.2	-	-	-
September 11	-	-	-	-
September 12	-	Removed	82.7	70.1
September 13	-		81.1	70.8
September 14	-		83.0	72.0
September 15	-		-	-
September 16	84.5		-	-
September 17	83.9		-	-
September 18	-		-	-
September 19	-		Removed	70.8
September 20	-			Removed
September 21	83.0			
September 22	-			
September 23	79.6			
Energy Average	84.1	78.2	82.7	70.5
Number of CNELs	45	28	15	19

Note: A dash, i.e., -, indicates that no CNEL was obtained for that day.

Table B2. 1979 CNEL measurements at NOSC monitoring sites.

Date	CNEL, dB					
	Building 186 (NTC)	Building 91 (NTC)	Building 570 (MCRD)	Building 312 (MCRD)	Building 251 (NTC)	Building 328 (NTC)
March 23	85.5	-	-	-	-	-
March 24	83.4	75.9	79.7	82.0	72.4	-
March 25	84.7	76.1	79.7	82.5	72.1	-
March 26	83.4	75.0	80.8	83.2	71.2	-
March 27	82.1	75.6	80.9	82.1	70.4	-
March 28	84.1	76.8	79.4	83.0	71.8	66.1
March 29	84.3	75.7	77.8	82.1	70.0	67.1
March 30	83.7	76.2	77.6	81.4	71.2	67.0
Energy Average	84.0	75.9	79.6	82.4	71.5	66.8
Number of CNELs	8	7	7	1	1	3

Table B2. 1979 CNEL measurements at NOSC monitoring sites. Continued.

Date	CNEL, dB			
	Building 186 (NTC)	Building 91 (NTC)	Building 570 (MCRD)	Building 312 (MCRD)
June 8	83.8	76.3	-	83.9
June 9	83.4	73.6	75.9	83.8
June 10	81.1	72.7	76.0	80.0
June 11	82.6	73.8	75.4	80.8
June 12	82.2	74.6	76.6	81.5
June 13	83.0	74.7	76.7	81.4
June 14	83.7	75.9	78.7	83.2
June 15	84.4	76.3	77.9	82.7
June 16	82.9	74.7	77.8	81.6
June 17	83.3	73.8	80.2	82.9
June 18	83.5	75.1	-	83.9
June 19	83.8	75.6	-	83.2
June 20	83.8	76.1	-	82.6
June 21	83.3	76.3	-	83.9
Energy Average	83.3	75.1	77.5	82.7
Number of CNELs	14	14	9	14

Note: A dash, i.e., -, indicates that no CNEL was obtained for that day.

APPENDIX C. CNEL CONTOUR PREDICTION

CNEL contour predictions can be generated by a computer program, such as NOISEMAP. Inputs include items such as number of aircraft operations, mix of jet and nonjet aircraft, flight path, altitude along flight path, time of landing or take-off, slant range to aircraft, sound exposure level of aircraft as a function of distance, and runway usage percentage.

Some information is relatively easy to obtain. For example, the number and type of aircraft can be obtained from published flight schedules and observations of actual operations. Some information can be obtained only with difficulty. Accurate slant range distance from aircraft to monitoring microphone(s) and related information concerning altitude and flight path are not easy to acquire. For the present set of contour predictions a photographic triangulation technique was used. Using the published lengths of aircraft and photographs obtained from locations near the flight track, close estimates of slant range, altitude, and path angle were obtained.

During aircraft observations, sound exposure levels were obtained at monitor sites for each aircraft take-off or landing. Sound exposure level is the level of sound accumulated as a time integral of the sound pressure squared during a given time period or event, such as an aircraft flyover. The reference duration is 1 s.

APPENDIX D. AIRCRAFT OPERATIONS MONITORING

Flight path distributions for aircraft departing from Runway 27 and landing on Runway 09 were determined by photographic triangulation techniques and by observation. Data taken for both photographic and visual determinations included angle of departure or landing in degrees magnetic, estimated aircraft height, aircraft type, and airline. Aircraft take-off observations were made on 5 days in addition to the photographic data. Landings were photographed on 1 day and observed for 3 additional days.

The angle of departure and angle of landing data were summarized to show the percentage of the total number of observed aircraft at a given angle. The higher percentages were found to cluster in the range of 270 to 273 deg. The mean angle of departure for the observed aircraft was 275.2 deg. The same mean angle of departure was assumed for 1985 projections. The mean angle of landing was 270 deg.

Sound exposure levels (SEL) were obtained at each of three monitor sites for each observed aircraft. These SEL data were plotted as a function of distance from aircraft to monitor site to establish the attenuation of aircraft SEL as a function of distance. Good agreement was observed between NOSC data and the data obtained from references 4, 5, and 6.

Runway usage logs by time of day were obtained through the courtesy of John Wilbur of the San Diego Port District to determine the relative usage of Runways 27 and 09.

Operational information that was used in the computer modeling of contours is contained in the NOISEMAP program summary chronicle available at Aircraft Environmental Support Office, NARF, NAS, North Island.

APPENDIX E. REFERENCES

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