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THE NOISE EXPOSURE MODEL MOD-5 VOLUME 1

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16. Abstract

This report contains three sections. The first two sections are contained in Volume 1 and may be described as follows:

Section 1. Airport Analysis - This section describes the Noise Exposure Model MOD-5 from the perspective of analysing an airport in order to develop the program input model.

Section 2. User's Manual - This section describes the process of developing the input model for the Noise Exposure Model MOD-5 from input data.

The final section will be published as Volume 2 and will be a programmer's manual. The purpose of this section will be to describe the Noise Exposure Model MOD-5 Computer Program.

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

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INTRODUCTION

The purpose of this report is threefold:

1. To record the results of efforts by the Transportation Systems Center to refine and expand the Noise Exposure Model for airport noise, resulting in the MOD 5 version described herein;

2. To serve as a User's Manual for preparation of input information for the Noise Exposure Model MOD 5; and

3. To document the computer program for the Noise Exposure Model MOD 5, primarily for the guidance of computer programmers.

This document is divided into three sections, the first of which outlines the method for analyzing an airport in order to compile the information needed for the simulation of airport noise. Also included in this section is an explanation of the three indices used to determine noise exposure in the vicinity of an airport. The second section, or User's Manual, explains the method for preparing the information assembled in the first section for use by the Noise Exposure Model MOD 5 simulation computer program, by discussing the input card format and the structure of the data deck.

The third section, Volume II of this document, is a discussion of the Noise Exposure Model MOD 5 from a programming viewpoint. The subroutines are explained since the principle structure of the program is flow charted.

The same model airport, Sample Airport 1975, is used for all illustrations and examples throughout the report.

BACKGROUND

The initial version of the Noise Exposure Model (designated the MOD 0 version for identification) was developed by Serendipity, Incorporated*, of Arlington, Virginia, under Contract DOT-OS-A9-018 to the Office of Noise Abatement, Office of the Secretary, Department of Transportation. In general, the model was based on the draft Aerospace Recommended Practice 1114 of the Society of Automotive Engineers (SAE ARP 1114), dated 24 March 1970: "Procedures for Developing Aircraft Noise Exposure Contours Around Airports." In September 1970, a copy of the MOD 0 version, originally programmed for a Burroughs 5500 computer, was delivered to the DOT Transportation Systems Center for refinement and expansion. The MOD 5 version described in this report is the result of TSC's efforts from September 1970 to November 1971. The earlier MOD 4 version is described in Report DOT-TSC-OST-71-14, dated August 1971.

The Noise Exposure Model MOD 5 (NEM-5) is programmed in FORTRAN IV specifically for use with the IBM 360/75 computer. It includes the following features:

1. Ability to calculate Noise Exposure (NE) using flight statistics for an entire 24-hour day, Noise Exposure Forecast (NEF) using flight statistics for two separate periods during a day (normally taken as 0700-2200 and 2200-0700), or Weighted Equivalent Continuous Perceived Noise Level (WECPNL) using a three-period day (normally 0700-1900, 1900-2200, and 2200-0700);

2. Presentation of calculated results as a grid array of up to 20 points in the X-direction by 25 points in the Y-direction in the horizontal plane (Z=0), or as plots of contours of the selected noise exposure index plus the area contained within each contour; up to three contour values may be specified;

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* "A Study of the Magnitude of Transportation Noise Generation and Potential Abatement", Volume III - Airport/Aircraft System Noise, Report OST-ONA-71-1, November 1970.

3. Ability to handle up to 150 flights (a flight is defined as a combination of a single aircraft class, but any number of aircraft within a class, a specific runway, and a specific flight path);

4. Ability to define flight paths as any combinations of up to 9 straight-line and constant-radius curved segments projected onto a horizontal plane (Z=0) plus a climb (or descent) angle;

5. Ability to consider up to ten runways, the ends of which can be described by three (X,Y,Z) coordinates;

6. Option to use either metric or English units of length and aircraft weight;

7. Option to use the values of takeoff ground roll and climb angle assumed in the SAE ARP 1114 procedure, which are included in the programmed model, or to override the programmed values with user-selected values of takeoff ground roll and initial climb angle; and

8. Option to use the SAE ARP 1114 aircraft noise characteristics included in the MOD 5 version or to override the programmed tables with user-selected tables of aircraft noise characteristics as a function of distance and thrust.

NEM-5 also includes diagnostic and control options for the display of intermediate computational steps and diagnostic information, as possible aids to better understanding the program operation. The program listing, included as Appendix C to this report (but bound separately for convenience), also includes comment entries for clearer identification of the functions of the various portions.

The MOD 6 version at TSC is being developed for the Center's H-832/DDP-516 computer complex for on-line use of the model with interactive graphic input and display of calculated contours. The NEM-5 version was operational on 1 June 1971. It is anticipated that the MOD 6 version will be operational prior to 1 January 1972 and will be accessible from remote terminals.

NOISE EXPOSURE MODEL MOD 5 AIRPORT ANALYSIS

The Noise Exposure Model MOD 5 (NEM-5) was developed to compute values of a noise exposure index in the neighborhood of an airport. Three noise exposure indices have been included in this model and are denoted by NE, NEF and WECPNL. Each is a representation of the noise perceived by individuals on the ground near airports and is in general use in the United States and abroad.

1. Noise Exposure (NE). NE represents the cumulative noise exposure at points on the ground in the neighborhood of an airport, assuming equal weighting for all aircraft operations throughout a 24-hour day.

2. Noise Exposure Forecast (NEF). NEF represents the cumulative noise exposure at points on the ground in the neighborhood of an airport with nighttime (2200 to 0700 hours) aircraft operations receiving a heavier weighting.

3. Weighted Equivalent Continuous Perceived Noise Level (WECPNL). WECPNL represents the cumulative noise exposure at points on the ground in the neighborhood of an airport with aircraft operations during the evening (1900 to 2200 hours) receiving a weighting intermediate to those of daytime and nighttime operations.

Preliminary to using NEM-5 for the computation of one of these noise exposure indices for a particular airport, it is necessary to develop the following submodels.

1. The aircraft class submodel. This is the representation of the aircraft operating in and out of the airport as classes of aircraft with similar noise characteristics and operational descriptors.

2. The airport submodel. This is the geometric representation of the airport runways and nominal flight ground tracks used by each aircraft class.

3. The flight submodel. This is the representation of the aircraft class takeoff or landing profiles along the flight ground tracks.

4. The aircraft noise submodel. This is the representation of the noise generated by each aircraft class.

The definitive information needed by NEM-5 for each submodel and the procedure for developing this information is described in the following sections. The final section mathematically describes the noise exposure index submodels.

Throughout these sections a single sample airport, Sample Airport 1975, is used to demonstrate the development of the submodels and to display the noise exposure index results. Sample Airport 1975 has five aircraft classes operating along seven groundtracks in and out of two runways. The details of Sample Airport 1975 are introduced as needed for each submodel.

THE AIRCRAFT CLASS SUBMODEL

NEM-5 requires that the aircraft operating into and out of an airport be grouped into classes which have similar noise characteristics and operational descriptors. That is, all aircraft in each class may be considered to have the same aircraft noise submodel and to be able to follow the same nominal ground track for a takeoff or landing. To accomplish this, the aircraft can first be grouped according to number and type of engines, and each group can be subdivided according to operational descriptors determined by gross takeoff weight.

The standard* grouping by number and type of engines and associated aircraft class type numbers included in NEM-5 are listed in Table 1.

The standard profiles and generic operational descriptors included in NEM-5 are listed in Table 2. For each aircraft class type, the appropriate profile may be obtained as a function of gross weight from Table 3. If trip length data is available instead of gross weight, Table 4 may be used to obtain the standard profiles.

Whether a user accepts the standard data presented in Tables 1, 2, 3 and 4 or designates his own aircraft classes

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* If these groupings or aircraft class type numbers are not used, an appropriate aircraft noise model must be supplied by the user. The method of developing an aircraft noise model is discussed in the Section entitled, The Aircraft Noise Model.

TABLE 1

AIRCRAFT TYPE

Airline Transport Aircraft
1 4-engine HBPR turbofans
2 3-engine HBPR turbofans
3 4-engine LBPR turbofans
4 4-engine turbojets
5 3-engine LBPR turbofans
6 2-engine LBPR turbofans
General Aviation Aircraft and Small Transports
7 2-engine LBPR turbofans
8 4-engine turbojets
9 2-engine LBPR turbofans
10 2-engine turbojets
11 2-engine props
12 4-engine props

TABLE 2

DESCRIPTIONS OF STANDARD PROFILES

Profile	Length of Takeoff Roll	Thrust	Climb Angle
AA	2550 feet (780 meters)	100%	18° 25'
A	4000 feet (1220 meters)	100%	11° 48'
B	5500 feet (1625 meters)	100%	9° 35'
C	6800 feet (2070 meters)	100%	7° 35'
D	9200 feet (2800 meters)	100%	6° 00'
E	10600 feet (3230 meters)	100%	5° 00'
PA	2800 feet (850 meters)	100%	5° 11'

Profile	Length of Landing Roll	Thrust	Climb Angle
All	5280 feet (1610 meters)	45%	3° 00'

TABLE 3

AIRCRAFT CLASSIFICATION AND TAKEOFF PROFILES

AIRCRAFT TAKEOFF PROFILE CORRESPONDING TO GROSS WEIGHT*

Aircraft Class Type No.	AA	A	B	C	D	E
1	NA	NA	400 to 500	500 to 605	605 to 710	710 to 800
2	NA	200 to 250	250 to 300	300 to 350	350 to 400	400 to 450
3	NA	200 to 215	215 to 250	250 to 280	280 to 315	315 to 350
4	NA	NA	200 to 220	220 to 250	250 to 275	275 to 305
5	NA	100 to 115	115 to 135	135 to 150	150 to 170	NA
6	NA	60 to 80	80 to 100	100 to 120	NA	NA
7	40 to 50	50 to 60	NA	NA	NA	NA
8	24 to 31½	31½ to 38½	38½ to 42	NA	NA	NA
9	16 to 20	20 to 25	25 to 30	NA	NA	NA
10	up to 12	12 to 15	NA	NA	NA	NA
11		PA profile				
12		PA profile				

*In thousands of pounds

TABLE 4

AIRCRAFT CLASSIFICATIONS AND TAKEOFF PROFILES

AIRCRAFT TAKEOFF PROFILE CORRESPONDING TO TRIP LENGTH*

Aircraft Class Type No.	0-500	500-1000	1000-1500	1500-2500	2500-3500	3500-4500	4500+
1	B	B	B	B	C	D	E
2	B	C	C	D	D		
3	B	B	B	B	C	D	E
4	B	B	B	C	D	E	E
5	B	C	D	D	D		
6	B	B	E	E			

*In nautical miles for trip length

or operational descriptor data, Form 1 (Appendix A) may be used to supply the information necessary for the use of NEM-5. Figure 1 is a Form 1 which has been completed for the sample airport.

It should be noted that any of the operational descriptors appearing in Table 2 may be varied; the user need only enter his own quantities on Form 1. However, the aircraft classes must be numbered from one to twelve and defined as shown in Table 1 if the built-in NEM-5 aircraft noise data are to be used. If the user wishes to input his own aircraft classes and noise data, he should assign three-digit numbers to his aircraft classes.

THE AIRPORT SUBMODEL

The airport submodel for NEM-5 is a geometric description of the runway and flight ground tracks. This implies the choice of a coordinate system. For simplicity the coordinate system can be chosen with its origin at one end of a runway and its X-axis along that runway. The scale can be chosen so as to be used conveniently with airport maps or drawings.

The runways are described by specifying the coordinates of their end points, with the end from which takeoff roll begins or touchdown takes place being specified first. Figure 2 depicts the sample airport runway configuration and demonstrates the runway specification. Form 2 (Appendix A) may be used to record this information for each runway as well as the following pertinent data:

TKGDRL: The average distance from the beginning of the runway (point A) to the point at which takeoff roll starts. This is nominally taken as zero.

TCHDWN: The average distance from the beginning of the runway (POINT A) to the point B at which landing aircraft touchdown. Figure 3 is a Form 2 filled out for runway 8 of the sample airport.

It should be noted that if both ends of a runway are used for takeoff and/or touchdown, then the runway is to be considered as two distinct runways and should be geometrically described in each direction. NEM-5 will accept up to ten runway descriptions.

After the runways have been described, it is necessary to specify geometrically the nominal ground tracks of the take off and landing flight paths from each runway. Figure 4 depicts a flight path and its ground track. The ground track is defined mathematically as the projection of the

FORM 1

AIRCRAFT CLASS Type No.	Profile	Gross Weight	Length of Takeoff Roll	Initial Climb Angle	Percent Thurst Takeoff	Length of Landing Roll	Final Descent Angle	Percent Thurst Landing
111	P1	350,000	3350	4.92°	100%	2000	3°	60.7%
134	P2	100,000	1300	14.73°	100%	1500	3°	45%
151	P3	65,000	1600	8.37°	100%	1200	3°	35.4%
154	P4	60,000	2000	8.92°	100%	1200	3°	42%
161	P5	43,000	1525	8.75°	100%	1200	3°	40%

☐ FEET/POUNDS

☒ METERS/KILOGRAMS

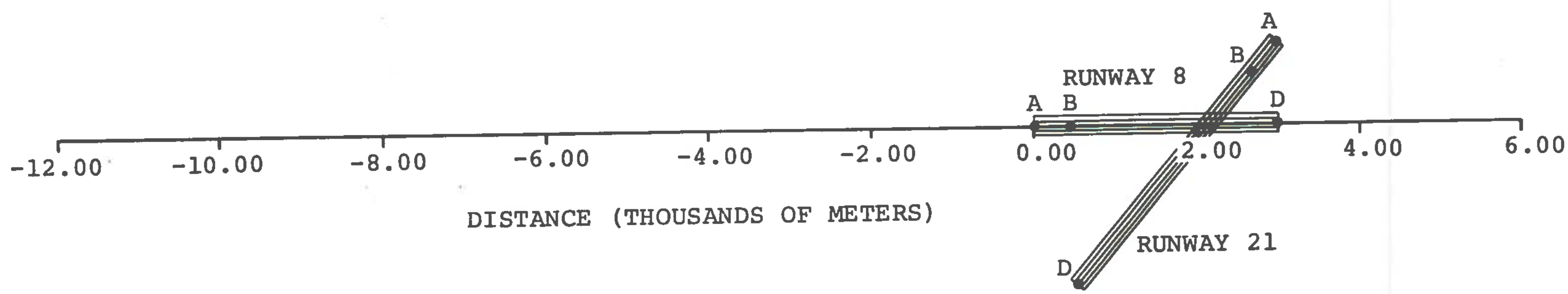

Figure 2. Sample Airport 1975 Runway Configuration

FORM 2

	A Beginning of Runway	D End of Runway	Runway Name
			8
x (coordinates)	0	3000	
y (coordinates)	0	0	
z (coordinates)	0	0	
TKGDRL Start of take off roll (AC)	0		
TCHDWN Touchdown Distance (AB) from point A	300		

☐ FEET/POUNDS

☒ METERS/KILOGRAMS

Figure 3. Runway Coordinate Data

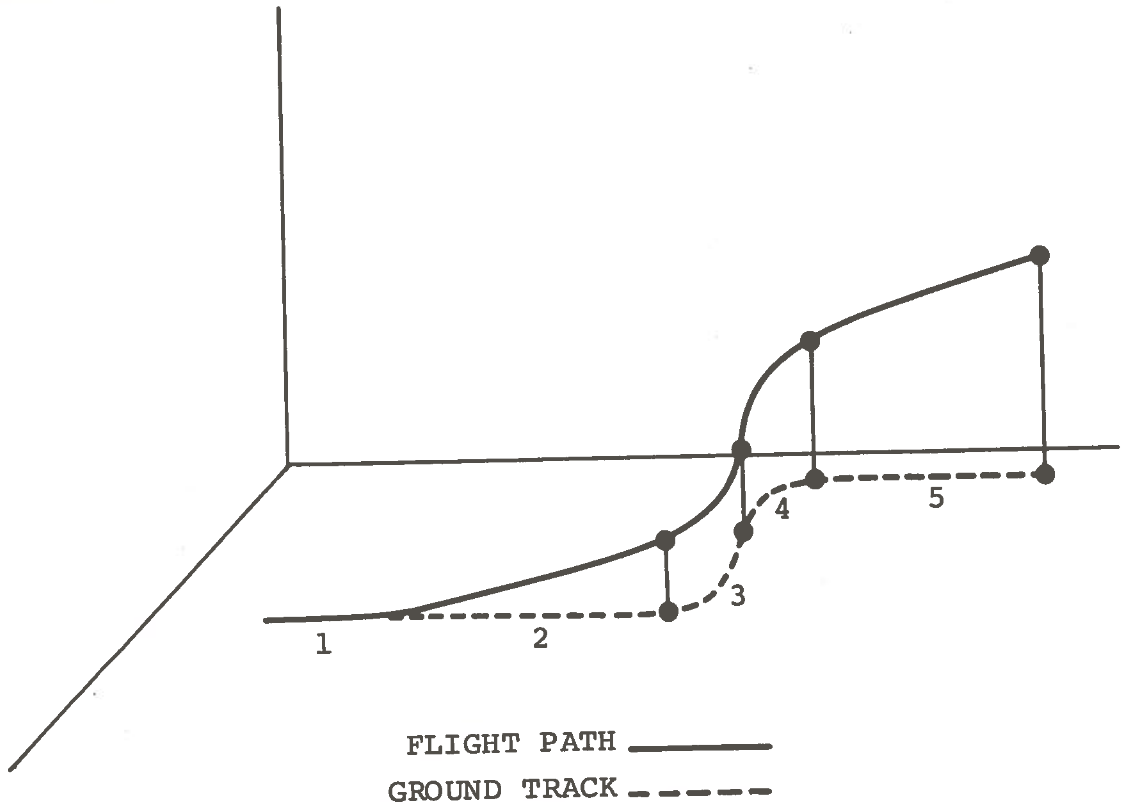

Figure 4. Ground Track As Projection of Flight Path

flight path onto the horizontal plane defined by the airport surface.

Each ground track must be described for NEM-5 in terms of straight line and circular segments as depicted in Figures 5A and 5B. The first two segments are the minimum allowable ground track description and must be colinear straight lines. The first of these always represents the roll distance. The second is the initial climb if it is a takeoff ground track or the final descent if it is a landing ground track. The remaining segments, if any, may be linear or circular and are referred to as extensions.* Each ground track may have up to seven extensions. It should be noted that for both takeoff and landing ground tracks, the segments are numbered in ascending order from the runway out.

The information required for each ground track submodel is quite basic. Each linear segment is specified by its length and each circular segment is specified by its turn radius and turn angle (see Figures 5A and 5B). When describing the ground track, if there are no extensions, only the runway and ground track names are required since the length of segment one is actually determined by the aircraft class and segment two is assumed to extend indefinitely. If there are extensions the combined length of segments 1 and 2 is required as well as the length of each linear segment and the turn radius and angle of each circular segment.

Form 3A (Appendix A) is used to record the ground track information as delineated below. Form 3B (Appendix A) is used when the ground track has more than 2 extensions.

1. Record the name of the runway being analyzed

2. Record the name of the ground track being analyzed

3. Record the number of extensions on the ground track. If there are zero extensions, the information for this ground track is now complete.

4. If the number of extensions is not zero, record the combined length of segments one and two. Since the roll distance (segment 1) is a function of the aircraft class, only the combined length can be considered as determined by airport geometry.

5. Record the turn angle and radius of each extension in order. If the extension is linear, record its

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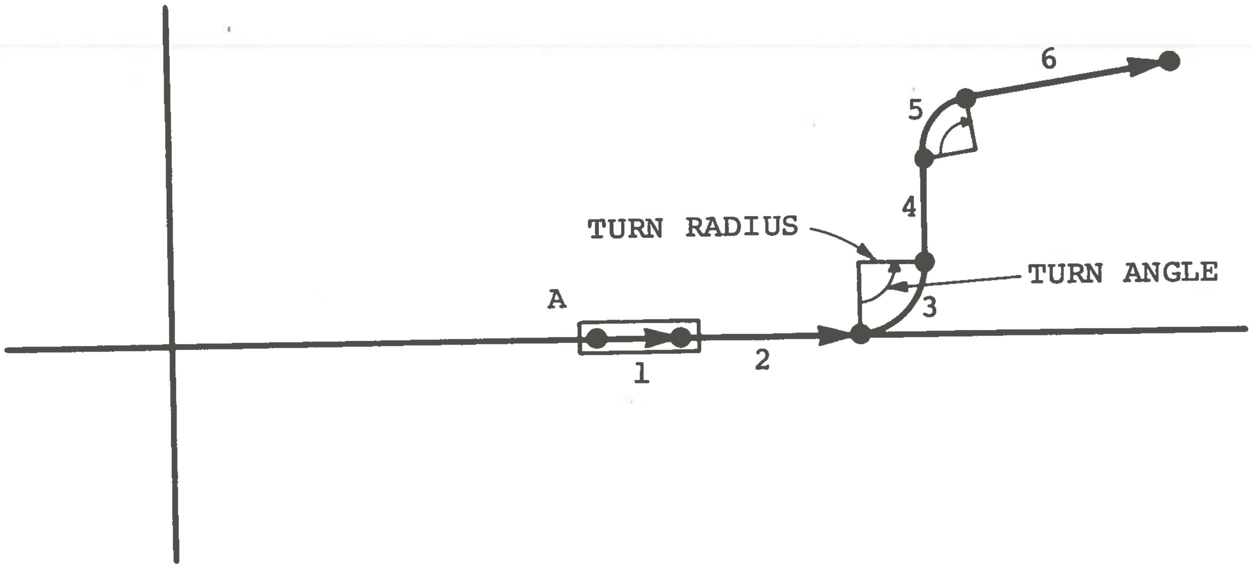
*Note that every extension is a segment, but the first two segments are not extensions.



SEGMENT 1 - TAKEOFF ROLL TRACK

SEGMENT 2 - INITIAL CLIMB TRACK

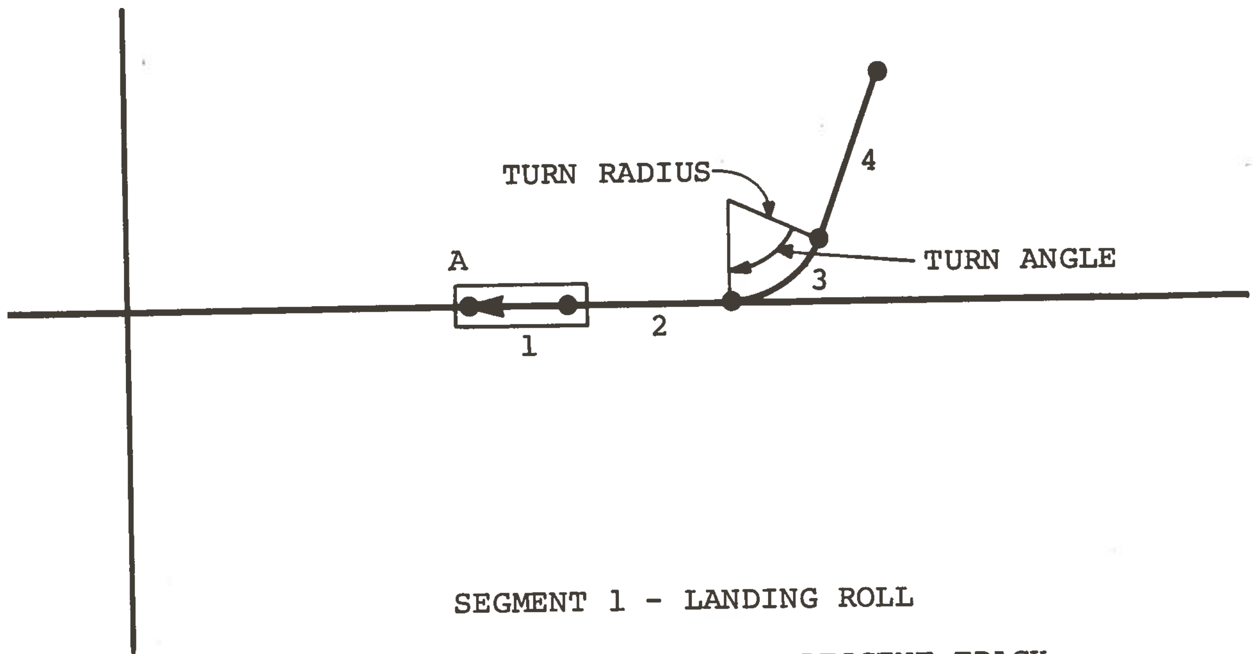
SEGMENT 3 - (EXTENSION 1) CIRCULAR TURN & CLIMB TRACK

SEGMENT 4 - (EXTENSION 2) CLIMB TRACK

SEGMENT 5 - (EXTENSION 3) CIRCULAR TURN & CLIMB TRACK

SEGMENT 6 - (EXTENSION 4) CLIMB TRACK

Figure 5A. Takeoff Ground Track With 6 Segments



SEGMENT 1 - LANDING ROLL

SEGMENT 2 - FINAL DESCENT TRACK

SEGMENT 3 - (EXTENSION 1) CIRCULAR TURN & DESCENT TRACK

SEGMENT 4 - (EXTENSION 2) DESCENT TRACK

Figure 5B. Landing Ground Track With 4 Segments turn angle as zero and then its length. If the extension is circular, record the turn angle, then the radius is recorded as positive for a clockwise turn and negative for a counter-clockwise turn of the runway.

The final extension for all ground tracks should be an infinite linear one. As in the case of all linear extensions, the turn angle is recorded as zero. Although the length of the segment is actually infinite, for purposes of the NEM-5 program, it is entered on Form 3 as zero.

6. Repeat the process from step 2 until all ground tracks for the specified runway have been described.

7. Repeat the process from step 1 on a new Form 3 until all ground tracks for all runway have been described.

It should be noted that two or more consecutive segments may be linear but if this occurs they must be colinear. That is, the ground track may not change direction except by means of a circular turn. There are no restrictions on consecutive circular segments. The total number of extensions on all ground tracks for all runways may not exceed 400.

Figure 6 depicts the sample airport configuration and Forms 3A and 3B (Appendix A) can be used to record the ground track information. Figure 7 shows Form 3A filled out for the sample airport case.

THE FLIGHT SUBMODEL

The NEM-5 flight submodels are representations of the flight paths and the characteristics of aircraft classes as they operate above the ground tracks. Figure 8 describes a flight path. Since the aircraft classes and ground tracks have already been defined, it is only necessary to delineate the information pertinent to both in order to complete the flight submodels.

For a given aircraft class operating along a particular ground track, the flight submodel may be defined by specifying whether the operations are landings or takeoffs, the number of operations per (24-hour) day, the length of ground track segment 2, and the aircraft class thrust and climb angle on each extension of the ground track. Form 4A (Appendix A) is used to record the flight submodel information as delineated below. Form 4B (Appendix A) is used when the flight path has more than 2 extensions.

1. Record the runway.

2. Record the ground track.

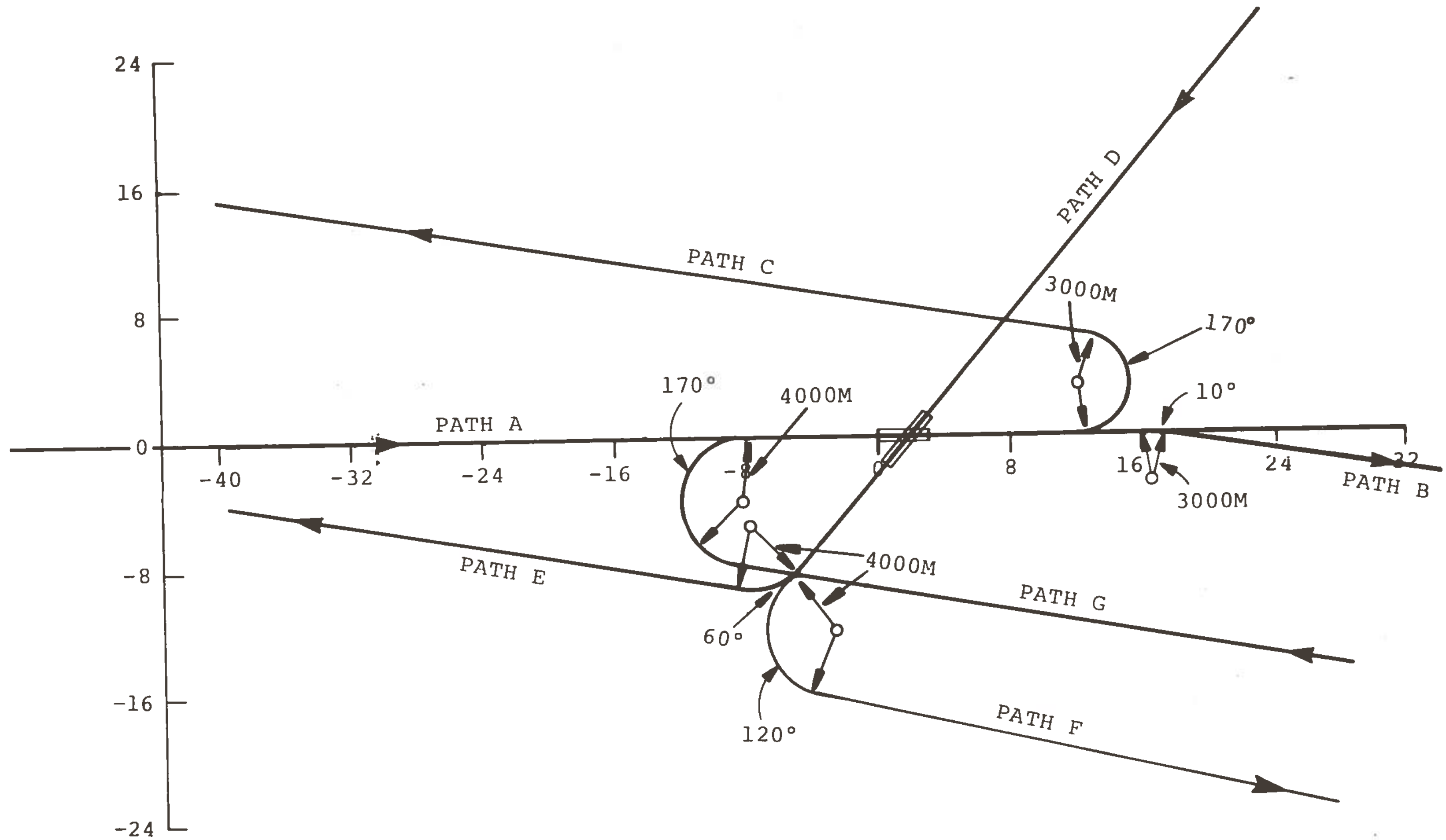


Figure 6. Sample Airport 1975 Configuration

FORM 3A

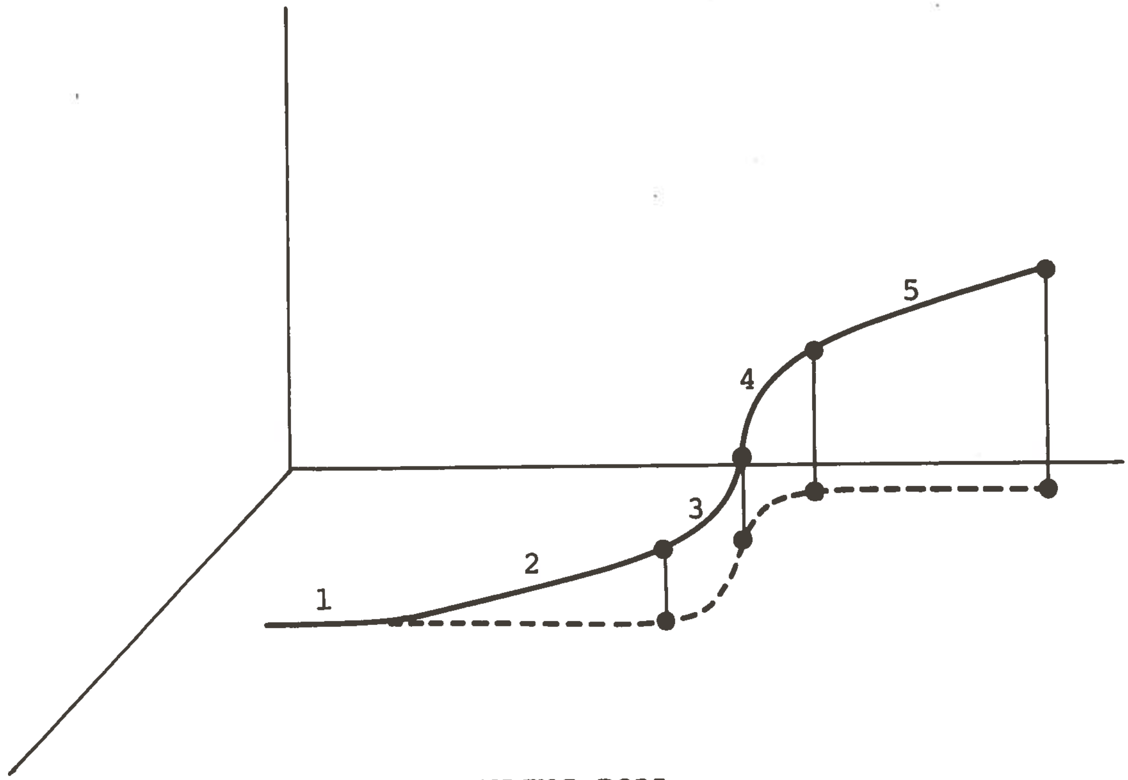
Runway 8

Ground Track	Number of Extensions	Segments 1 and 2	Extension 1 Length or Radius	Extension 1 Turn Angle	Extension 2 Length or Radius	Extension 2 Turn Angle
G	2	8300	-4000	170	0	0
A	0					
B	2	17000	3000	10	0	0
C	2	12000	-3000	170	0	0

☐ FEET/POUNDS

☒ METERS/KILOGRAMS

Figure 7. Airport Ground Track Data Form



1. TAKEOFF OR LANDING ROLL
2. TAKEOFF - INITIAL CLIMB

   LANDING - FINAL DESCENT
3. TAKEOFF - COUNTERCLOCKWISE TURN & CLIMB

   LANDING - COUNTERCLOCKWISE TURN & DESCENT
4. TAKEOFF - CLOCKWISE TURN & CLIMB

   LANDING - CLOCKWISE TURN & DESCENT
5. TAKEOFF - CLIMB

   LANDING - DESCENT

Figure 8. Multiple Segment Flight Path

3. Record the aircraft class type number and profile designation.

4. Specify whether the aircraft class operations are takeoffs or landings. Each flight submodel must be all takeoffs or all landings.

5. Specify the number of takeoff or landing operations. If NE values are to be computed, the number of takeoffs or landings for a 24-hour period is entered in the column for day operations, and the columns for evening and night operations are not used. For NEF values, the number of takeoffs or landings between 0700 and 2200 is entered in the column for day operations and the number of takeoffs or landings between 2200 and 0700 is put in the night column. If WECPNL values are to be computed, the day column is for all operations from 0700 to 1900, the evening column is for operations from 1900 to 2200 and in the night column is entered the number of operations from 2200 to 0700.

6. Specify the length of segment 2 of the ground track. Subtract the aircraft class roll distance from the combined length of segments 1 and 2 of the ground track to obtain this.

7. Specify the thrust and climb (or descent) angle of the aircraft class on each extension of the ground track. If there are more than two extensions use Form 4B to continue. The flight submodel being continued may be designated by its runway, ground track, aircraft class type number and profile, and a T or L for takeoff or landing.

8. Repeat the process from step 2 until all flight submodels for the runway have been defined. Each runway may have up to 20 flight submodels. If more than 20 are required, the runway may be redefined and the additional flights entered.

9. Repeat the process from step 1 until all flights for all runways have been defined. A maximum of 150 flight submodels is allowed for an airport.

   Figure 9 is Form 4A filled out for one runway of the sample airport. If a flight path has more than 2 extensions, then Form 4B is used. The flight is labeled in the first column by runway name, ground track designation, aircraft class and

FORM 4A

Runway 8

	Ground Track	Aircraft Class Type No.	Aircraft Class Profile	Landing or Takeoff	Number of Operations Day	Number of Operations Eve.	Number of Operations Night	Length of Segment 2	Extension 1 Thrust	Extension 1 Angle in Degrees	Extension 2 Thrust	Extension 2 Angle in Degrees
1	G	154	P4	L	12	2	2	7100	42	3	42	3
2	G	151	P3	L	8	2	6	7100	35.4	3	35.4	3
3	A	154	P4	L	26.4	7.6	11					
4	A	161	P5	L	31	7	9					
5	B	154	P4	T	27.2	6.8	6	15000	100	8.92	100	8.92
6	B	151	P3	T	7	1	3	15400	100	8.37	100	8.37
7	B	161	P5	T	5	2	2	15475	100	8.75	100	8.75
8	C	154	P4	T	9.4	4.6	7	10000	100	8.92	100	8.92
9	C	151	P3	T	4	1	0	10400	100	8.37	100	8.37
10	C	161	P5	T	10	3	4	10475	100	8.75	100	8.75
11												
12												
13												
14												

☐ FEET/POUNDS

☒ METERS/KILOGRAMS

Figure 9. Flight Model Data

profile, e.g. 8C - 154P4.

THE NOISE EXPOSURE INDEX SUBMODELS

Each of the three noise exposure index submodels relates noise exposure at an observer's position to the noise generated by all operations during a 24-hour period from each flight submodel on each runway of an airport. The total noise exposure at the observer's position is then obtained by summing overall flight submodels and runways.

Preliminary to discussing the mathematical models of the noise exposure indices, it is convenient to make certain assumptions and definitions.

First, it is assumed that the runways have been serially numbered from 1 to NRW where NRW is the number of runways described in the airport submodel. It is also assumed that the flight submodels for each runway have been serially numbered from 1 to NFL(j) where NFL(j) is the number of flight submodels described for the j^{th} runway.

The following geometric quantities are depicted in Figure 10:

1. The observer's position P_1.

   $P_1 = P(x_1, y_1)$

2. The position $P^{i,j}_{1,2}$ of the point on the i^{th} flight path of the j^{th} runway which is closest to P_1.

   $P^{i,j}_{1,2} = P^{i,j}_{1}(x_2, y_2, z_2)$

3. The distance, $D^{i,j}_{1,2}$, from P to $P^{i,j}_{1,2}$. That is, the minimum distance from the observer to the i^{th} flight path of the j^{th} runway.

   $D^{i,j}_{1,2} = \left[(x_2-x_1)^2 + (y_2-y_1)^2 + (Z_2-0)^2 \right]^{\frac{1}{2}}$

4. The elevation angle, $B^{i,j}_{1,2}$, of an aircraft at $P^{i,j}_{1,2}$ as seen from P_1.

   $B^{i,j}_{1,2} = \arcsin\left(\dfrac{z^2}{D^{i,j}_{1,2}}\right)$

Further definitions related to perceived noise are:

1. The uncorrected effective perceived noise level, $EPNL(D^{i,j}_{1,2})$, at P_1, due to a single aircraft of the

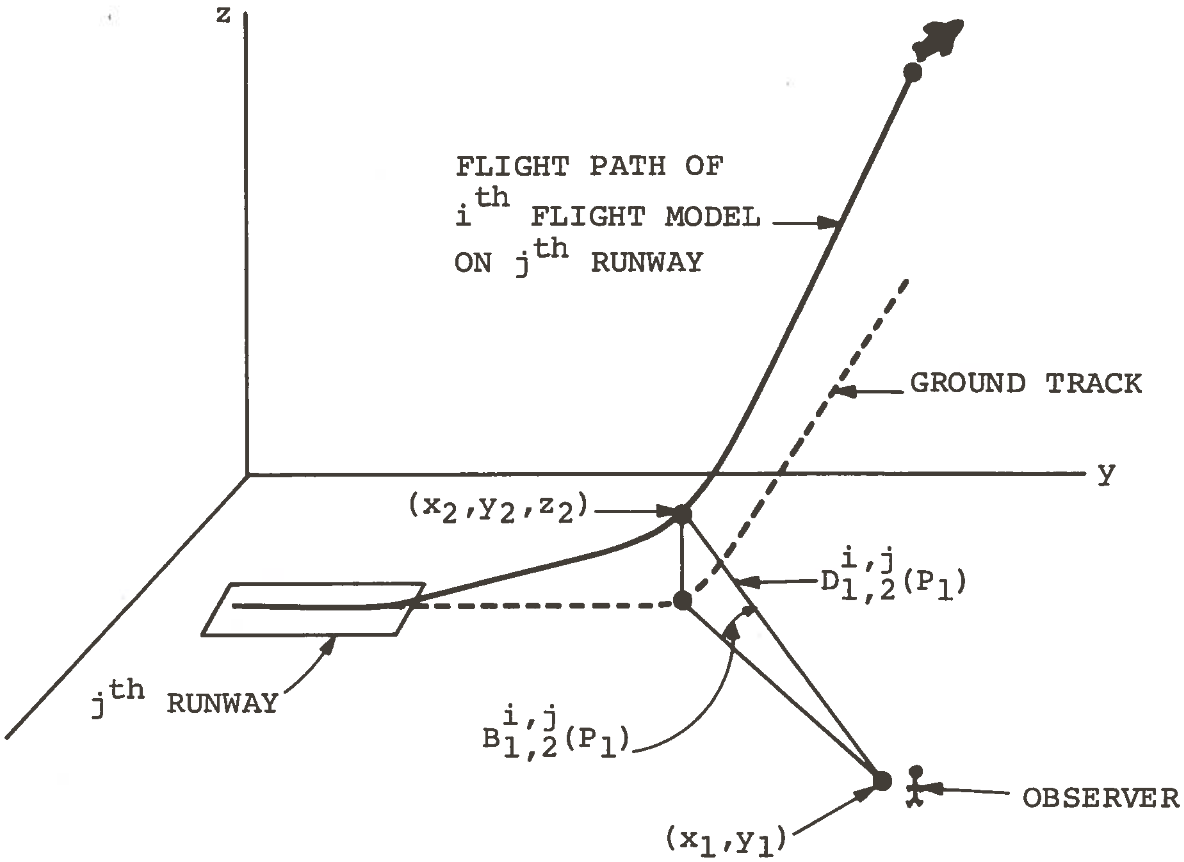


Figure 10. Geometric Quantities Used For Noise Exposure Index Models

i^{th} flight submodel on the j^{th} runway.

2. The ground attenuation correction term, $A(B_{1,2}^{i,j}, D_{1,2}^{i,j})$, used to correct the effective perceived noise level at P_1.

Using the above definitions, the Noise Exposure at P_1 due to the i^{th} flight submodel on the j^{th} runway can be written as

$$NE_{i,j}(P_1) = EPNL(D_{1,2}^{i,j}) + 10 \log N(i,j) - A(B_{1,2}^{i,j}, D_{1,2}^{i,j}) - 88$$

where N(i,j) is the number of aircraft operations in a 24-hour day in the i^{th} flight submodel of the j^{th} runway. The total Noise Exposure index is then written:

$$NE(P_1) = 10 \log \left[\sum_{j=1}^{NRW} \sum_{i=1}^{NFL(j)} \text{antilog} \left(\frac{NE_{i,j}(P_1)}{10} \right) \right]$$

The Noise Exposure Forecast at P_1 due to the i^{th} flight submodel on the j^{th} runway can be written as:

$$NEF_{i,j}(P_1) = EPNL(D_{1,2}^{i,j}) + 10 \log \left| ND(i,j) + 16.67NN(i,j) \right| - A(B_{1,2}^{i,j}, D_{1,2}^{i,j}) - 88$$

where ND(i,j) is the number of daytime aircraft operations (0700 to 2200) and NN(i,j) is the number of night aircraft operations (2200 to 0700) in the i^{th} flight submodel of the j^{th} runway. The total Noise Exposure Forecast is then written:

$$NEF(P_1) = 10 \log \left[\sum_{j=1}^{NRW} \sum_{i=1}^{NFL(j)} \text{antilog} \left(\frac{NEF_{i,j}(P_1)}{10} \right) \right]$$

The Weighted Equivalent Continuous Perceived Noise Level at P_1 can be written:

$$WECPNL(P_1) = \sum_{k=1}^{3} W_k \text{ antilog} \left(\frac{NE_k(P_1)}{10} \right)$$

with weighting coefficients $W_1 = .5$, $W_2 = .125$ and $W_3 = .375$.

Here, $NE_k\ (P_1)$ is defined by:

$$NE_k(P_1) = 10 \log \left[\sum_{j=1}^{NRW} \sum_{i=1}^{NFL\ (j)} \text{antilog}\ \frac{NE_k^{i,j}(P_1)}{10} \right] - C_k$$

$$\{k=1,2,3\},$$

where $C_1 = 36.35$, $C_2 = 30.33$, $C_3 = 35.11$ and:

$$NE_k^{i,j}(P_1) = EPNL(D_{1,2}^{i,j}) + 10 \log N_k^{i,j} - A(B_{1,2}^{i,j}, D_{1,2}^{i,j}),$$

$$\{K=1,2,3\}.$$

$N_k^{i,j}$ is the number of operations from the i^{th} flight submodel of the j^{th} runway during the k^{th} time period, where:

k=1, day operations from 0700 to 1900 hours,
k=2, evening operations from 1900 to 2200 hours,
K=3, night operations from 2200 to 0700 hours.

Along with the information defining the other submodels, it is necessary to specify which noise exposure index submodel is desired, the observer positions at which the noise exposure index values are to be computed and the values at which noise exposure index contours, if any, are to be evaluated. Form 5 (Appendix A) may be used for this purpose. Figure 11 is a Form 5 filled out for the sample airport.

First, the noise exposure index chosen is specified by checking the appropriate box on Form 5. It should be noted that this choice is implicitly made when Form 4 is filled out since day, day-night, or day evening-night operations must be specified on that form.

Second, the grid of observer positions at which the noise exposure index is to be calculated must be defined. This is done by specifying, relative to the frame of reference used for the airport submodel, the following numbers:

x_o: The smallest (left-most) x coordinate at which the noise exposure index is to be computed.

FORM 5

NOISE EXPOSURE INDEX TO BE CALCULATED

☐	NE
☐	NEF
X	WECPNL

OBSERVER'S GRID FOR NOISE EXPOSURE INDEX CALCULATION

x_o	-32500.
y_o	25500.
Δx	3000.
Δy	-3000.
Nx	20.
Ny	18.

NOISE EXPOSURE INDEX CONTOUR VALUES

1	80.
2	85.
3	90.

Figure 11. Noise Exposure Index Model Information

Δx: The increment to be used in obtaining the x coordinates of the other observer positions in the noise exposure index grid. $\Delta x>0$.

Nx: The number of observer positions in the x direction of the noise exposure index grid. $Nx \leq 20$.

y_o: The largest (top-most) y coordinate at which the noise exposure index is to be computed.

Δy: The increment to be used in obtaining the y coordinate of the other observer positions in the noise exposure index grid. $\Delta y<0$.

Ny: The number of observer positions in the y direction of the noise exposure index grid. $Ny \leq 25$.

In specifying the Δx, Δy, Nx and Ny for a grid, the user must select these values so that no points lying on a runway are computed. This is necessary in order to avoid zero distances in noise calculation.

Figure 12A is a sample of WECPNL values for the sample airport calculated over the grid specified in Figure 11, overlayed on the airport configuration.

Third, the noise exposure index values for which contours are desired must be specified. If no contours are desired, the contour section of Form 5 is left blank. If contours are desired, the noise exposure index values for the contours are entered. A maximum of three contours is accepted by NEM-5. Figure 12B is a set of three WECPNL contours (overlayed in red) obtained for the sample airport, overlayed on Figure 12A for the purpose of comparing the contours with the WECPNL grid calculations and airport geometry.

----

*It should be noted that Figure 12A contains only half of the grid points at which WECPNL values were computed for Sample Airport 1975. Hence not all the WECPNL values which determine the contours of Figure 12B are present.

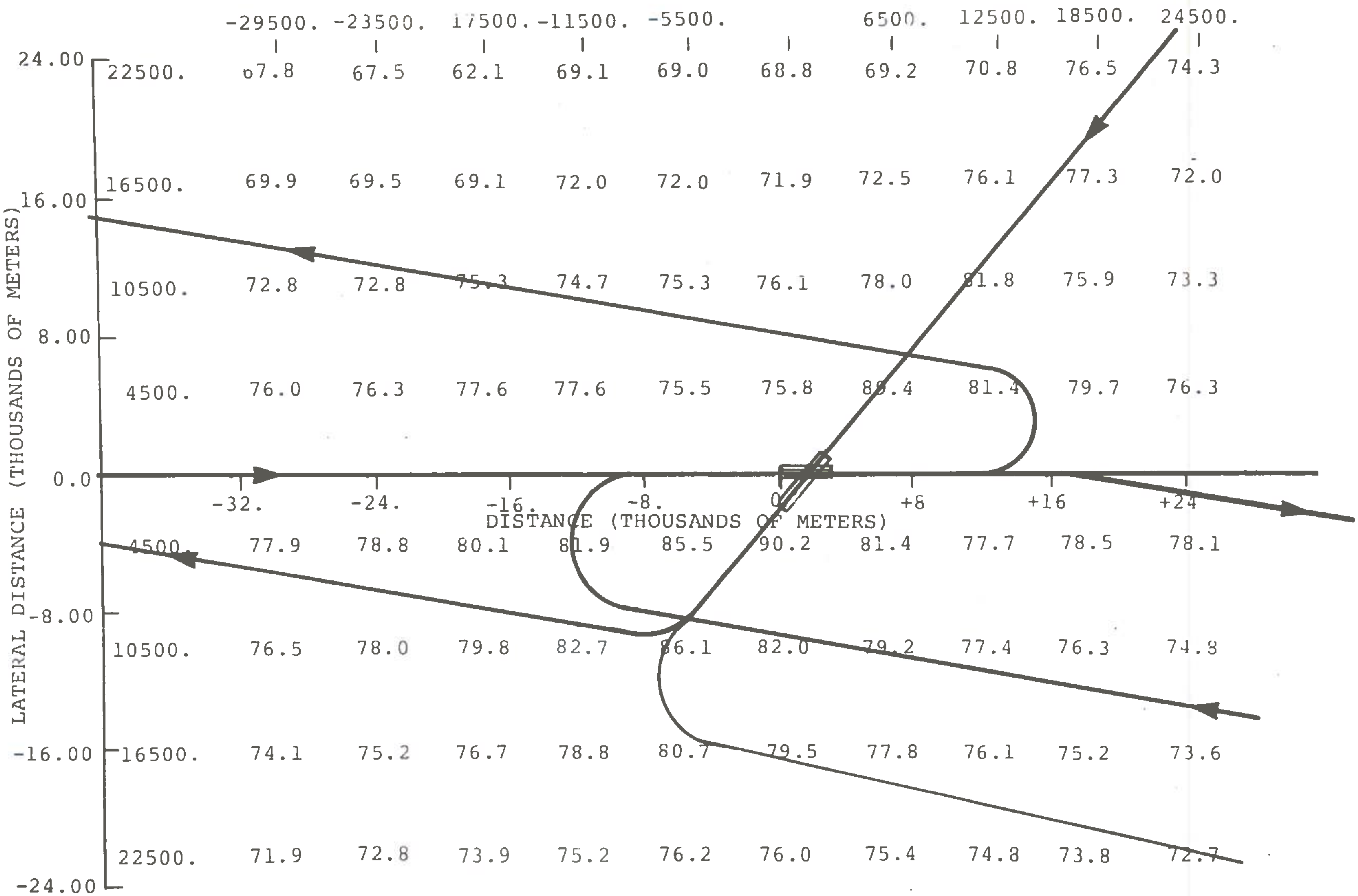


Figure 12A. WECPNL Values In The Grid

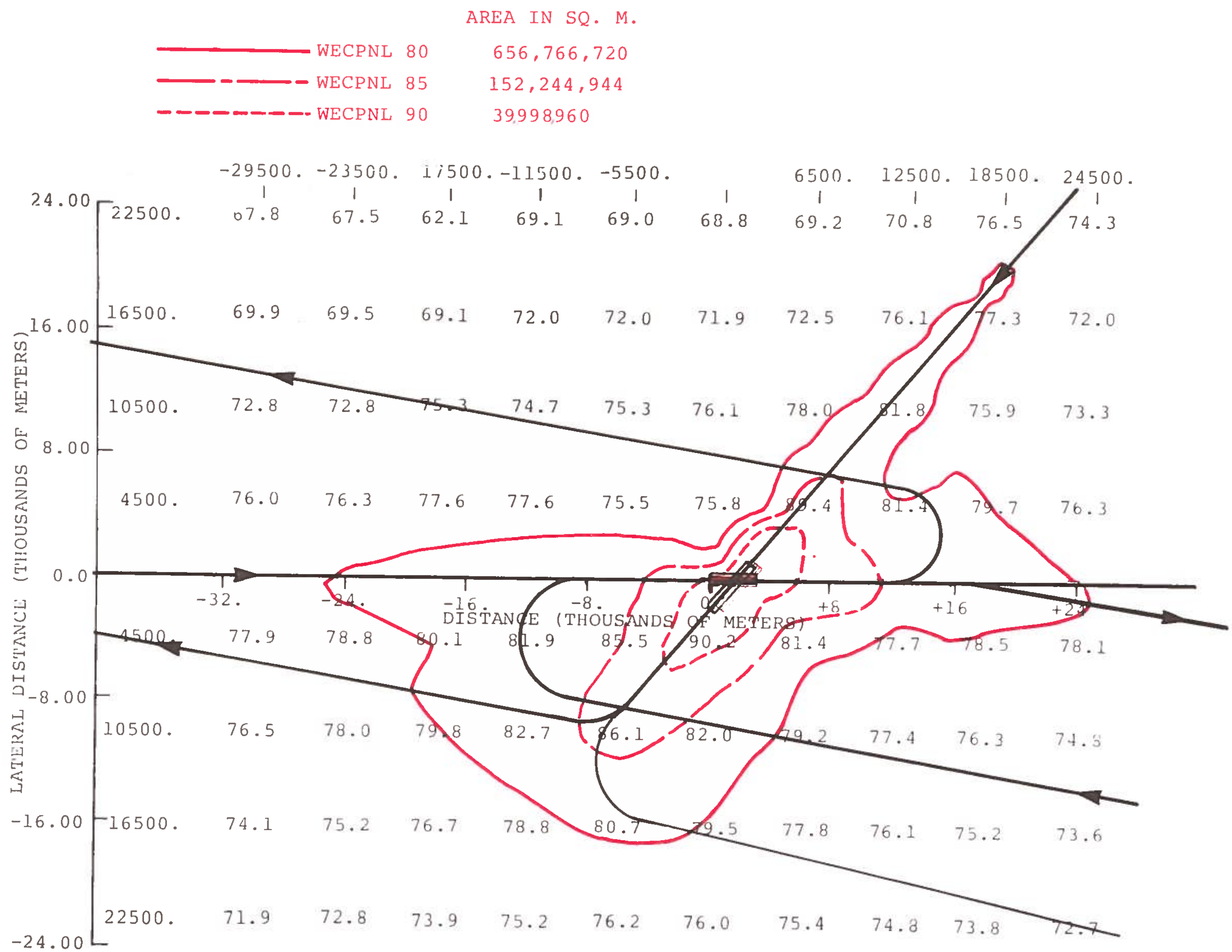


Figure 12B. WECPNL Contours For Sample Airport

USER'S MANUAL

INTRODUCTION

The User's Manual of this document is designed to acquaint the user with the actual card format and over-all structure of the data deck. The use of option cards which determine the output will be explained, as well as the method by which the user is able to transfer the specific data pertaining to his airport from the Sample Forms 1-5 completed in the previous section to data cards in a format which can be interpreted by the NEM-5 program. The order of the data deck will be discussed and a complete listing of Sample Airport 1975 is included so that the user may see the structure of a correctly compiled data deck.

The discussion of the data cards is followed by an explanation of the control cards needed to run the program from tape and the data from cards on an IBM 360-75.

Option Cards

The preparation of the input data deck begins with a title card followed by several option cards which indicate the type of output desired by the user. All possibilities are listed and explained below, followed by coding forms completed for the option cards required for Sample Airport.

<u>Col. 1-6</u>

TITLEE	Instruction indicator

Title of the airport appears on the following card in columns 1 - 21 only.

FEETLB	Input data is in feet and pounds; output will be in feet and pounds also.
MKSSYS	Input data is in meters and kilograms; output will be in meters and kilograms also.

The inclusion of one of the above two cards is mandatory.

DIAGLO	No diagnostics printed.
DIAGL1	Extensive diagnostics printed.

DIAGL3	Complete diagnostics printed.

One of the above three cards need be included only if the programmer wishes to determine how certain calculations were made. They are not necessary to produce the type of output usually desired.

NEEVAL	Noise Exposures Values to be calculated.
NEFCAL	Noise Exposure Forecast Values to be calculated.
WECPNL	Weighted Equivalent Continuous Perceived Noise level Values to be calculated.

One of the above three cards must be included. The differences in the three values as well as the type of input they require were discussed in the previous section.

PRTALL	Print all input and output data and some calculated tables.

The inclusion of this card is not mandatory but highly desirable since its omission will result in no output being printed.

CLCMPS	Small size, (12 inch), CALCOMP plots output.
CLCMPL	Large size, (30 inch), CALCOMP plots output.

One of the above two cards must be included if the user wishes the output to be plotted as contours.

SETPLT	The user wishes to specify the scaling of the CALCOMP plot. If this instruction is used, the following eight cards are also required.
DELTAX	X increment on the X-axis in thousands with mandatory decimal point in col. 18.
DELTAY	Y increment on the Y-axis in thousands with mandatory decimal point in col. 18.

AINCHX	Length of the X-axis in inches with mandatory decimal point in col. 18.
AINCHY	Length of the Y-axis in inches (maximum of 10 inches) with mandatory decimal point in col. 18.
AXMAXV	Maximum value of X to be plotted (in thousands) with mandatory decimal point in col. 18.
AXMINV	Minimum value of X to be plotted (in thousands) with mandatory decimal point in col. 18.
AYMAXV	Maximum value of Y to be plotted (in thousands) with mandatory decimal point in col. 18.
AYMINV	Minimum value of Y to be plotted (in thousands) with mandatory decimal point in col. 18.

The above nine cards need be included only if the user wishes to specify his own plot scale; however, if he prefers, the scale will be set automatically if he deletes the above group of cards.

NOISIN	The user wishes to include his own set of noise values rather than those automatically supplied by the program.

If the user prefers, the SAE noise values written into the program will be used if he deletes the NOISIN card. If he is going to access the noise values in the NEM-5 program, his aircraft type numbers must correspond to the classification in Appendix B. If this NOISIN card is included, however, cards supplying the noise data must be inserted after the runway and flight information. The format for those cards and their exact location in the input deck will be discussed later.

OPTION CARDS FOR SAMPLE AIRPORT 1975

FORTRAN CODING FORM

AUTHOR | PROGRAM NAME

STATEMENT NO. | CONT | FORTRAN STATEMENT →

```
TITLEE
SAMPLE AIRPORT 1975
MKSSYS
WECPNL
PRTALL
CLCMPS
NOISIN
```

AIRPORT AND AIRCRAFT DATA CARDS

The preparation of the data cards containing the airport and aircraft information may be approached in either of two ways. A Deck Generator Program is available and is discussed in Appendix C. The cards may also be keypunched from a set of coding forms, and it is this method that is explained on the following pages.

The input card format for runway and flight information is as follows:

Cols. 1 - 6	Six character instruction/data mnemonic
7 - 8	Blank
9 - 23	First data field (if any) with mandatory decimal point in col. 18.
24 - 25	Blank
26 - 40	Second data field (if any) with mandatory decimal point in col. 35.
41 - 80	Not read by program - may be used for user's comments.

This format must be strictly adhered to on both the coding forms and data cards.

On the following pages coding forms with the runway and flight information for Sample Airport have been completed with an explanation for each entry. The user will refer to Sample Forms 1-5 completed in the previous section to justify the quantities entered.

Following the option cards, the first runway is defined, followed, in turn, by the necessary information for all flights using that runway. This pattern is continued until all runways and flights have been entered.

The following terms are interpreted by the NEM-5 as defined below:

Flight - refers to a certain type of operation (either takeoff or landing), a given class and profile of aircraft, and a specific flight path.

Extension - refers to a change in direction of flight in angle of elevation or descent, or in engine thrust while the aircraft is in the vicinity of the airport.

Extent - one of the terms used in defining an extension; for a linear segment, the extent is the length of the ground projection of the segment in meters or feet; when referring to a helical segment, the extent is the angle in degrees of the turn.

Radius - also defines an extension; for a helical segment, it is the radius of the turn, a positive number if the turn is clockwise, and negative if it is counterclockwise; when the segment is linear, a zero is entered for the radius.

FORTRAN CODING FORM

AUTHOR | PROGRAM NAME

C | STATEMENT NO. | CONT | FORTRAN STATEMENT →

```
RUNWAY                                  8
XCOORD          0.            3000.
YCOORD          0.               0.
ZCOORD          0.               0.
TKGDRL          0.
TCHDWN        300.
NOFLTS         10.
```

RUNWAY — Identifies following information as pertaining to a new runway; the runway is identified in col. 41 for the user's convenience.

XCOORD	X-coordinate of point A of runway with mandatory decimal point in col. 18; X-coordinate of point D of runway with mandatory decimal point in col. 35.
YCOORD	Y-coordinate of point A of runway with mandatory decimal point in col. 18; Y-coordinate of point D of runway with mandatory decimal point in col. 35.
ZCOORD	Z-coordinate of end points of runway with mandatory decimal points in cols. 18 and 35. At this time, the program is equipped to handle only entries of zero (0) for the z coordinates.
TKGDRL	Take-off-ground roll distance taken from form 1, with mandatory decimal point in col. 18.
TCHDWN	Distance from point A of runway to touchdown point taken from Form 2, with mandatory decimal point in col. 18.
NOFLTS	Number of flights to be entered for this runway with mandatory decimal point in col. 18. This figure is the total of all flights on Form 4, completed for runway 8.

This is all the information necessary for defining a runway. After the initial RUNWAY identifier, the sequence of the other cards is unimportant so long as all are present. To facilitate program checks, however, it is strongly suggested that the same sequence be used for all runways included in the input deck.

A maximum of 10 runways is allowable for any one airport.

Following each set of cards like the above for each runway, there should appear sets of flight cards for each aircraft type using that runway. These cards should be grouped by flight paths as in the following examples, and the total number of flights for any one runway <u>must</u> equal the quantity entered opposite NOFLTS in the runway information. The maximum number of flights allowed for any one runway is 20. If it is necessary to consider more than 20 flights, the same runway may be redefined and additional flights extended.

FORTRAN CODING FORM

AUTHOR | PROGRAM NAME

```
FLIGHT                                  8 G 154
LANDNG
ACTYPE        154.
ACWGHT      60000.
THRUST         42.
NDAYOP         12.
NEVNOP          2.
NNGTOP          2.
NOEXTS          2.
CLIMBA          3.
PRSEG1       1200.
PRSEG2       8300.
```

FLIGHT	Identifies the following information as pertaining to a new flight; the runway, flight path, and flight number are designated in cols. 41-47 for the user's convenience.
LANDNG	Identifies this set of operations as applying to landings.
ACTYPE	Aircraft type from Form 4 with mandatory decimal point in col. 18.
ACWGHT	Gross weight of this aircraft type from Form 1, with mandatory decimal point in col. 18.
THRUST	Percent of engine thrust for this aircraft type and profile, with mandatory decimal point in col. 18.

*NDAYOP	Number of operations from 0700 to 1900 from Form 4 with mandatory decimal point in col. 18.
*NEVNOP	Number of operations from 1900 to 2200 from Form 4, with mandatory decimal point in col. 18.
*NNGTOP	Number of operations from 2200 to 0700 from Form 4, with mandatory decimal point in col. 18.
NOEXTS	Number of extensions for this flight path from Form 3, with mandatory decimal point in col. 18.
CLIMBA[1]	Angle of descent from Form 1, with mandatory decimal point in col. 18.
PRSEG1[1]	Length of landing roll, segment 1, from Form 1, with mandatory decimal point in col. 18.
PRSEG2	Length of ground projection of segment 2, from Form 4, with mandatory decimal point in col. 18. This card is entered only if there are extensions for this flight path.

As in the case of runway information cards, the order of the data following the FLIGHT card is immaterial. Here again, however, the user is strongly encouraged to adopt the same sequence throughout his input data deck. This

---

*When NE values are being computed, only the NDAYOP card will be entered. It will indicate the total number of operations within a 24-hour period. When NEF values are to be computed, 2 cards will be entered for each flight - NDAYOP, which will indicate the number of operations from 0700 to 2200 and NNGTOP, which will indicate the number of operations from 2200 to 0700. The example explained in the coding form above applies to cases which require WECPNL values.

[1]A chart of the CLIMBA and PRSEG1 values written into the NEM-5 program is found in Appendix B, or, if he prefers, the user may supply his own values.

consistency will help to prevent the error of deleting necessary data.

Regardless of whether the flight being described is a take-off or a landing, the flight path is defined beginning at point A on the runway and going away from the airport.

The first extension in flight path 8G is a helical one.

FORTRAN CODING FORM

AUTHOR | PROGRAM NAME

STATEMENT NO. | C | CONT | FORTRAN STATEMENT →

```
         1111111111222222222233333333334444444444
1234567890123456789012345678901234567890123456789
EXTNSN
EXTENT        170.
ELEVAT          3.
THRUST         42.
RADIUS      -4000.
```

EXTNSN	Identifies the following information as defining an extension.
EXTENT	Measurement of the angle (in degrees) that the aircraft turns in this helical segment, from Form 3, with mandatory decimal point in col. 18.
ELEVAT	Angle of descent for this segment of flight, from Form 4, with mandatory decimal point in col. 18.
THRUST	Percent of engine thrust for this segment of flight, from Form 4, with mandatory decimal point in col. 18.
RADIUS	Radius of the helical segment, from Form 3, with mandatory decimal point in col. 18.

The following example illustrates a coding form for the last segment of flight path 8G, which is an infinite linear extension. The final segment for any flight path with extension should be an infinite linear one.

FORTRAN CODING FORM

AUTHOR | PROGRAM NAME

STATEMENT NO. | CONT | FORTRAN STATEMENT →

```
EXTNSN
EXTENT          0.
ELEVAT          3.
THRUST         42.
RADIUS          0.
```

EXTNSN	Identifies the following information as defining an extension.
EXTENT	For an infinite linear segment, a zero (0.) is entered here, as shown on Form 3, with a mandatory decimal point in col. 18.
ELEVAT	Angle of descent of the aircraft for this segment, from Form 4, with a mandatory decimal point in col. 18.
THRUST	Percent engine thrust for this segment, from form 4, with mandatory decimal point in col. 18.
RADIUS	For an infinite segment, a zero (0.) is entered here, as shown on form 3, with a mandatory decimal point in col. 18.

The maximum number of extensions for any one flight is seven (7), but the total for the entire airport must not exceed 400.

On the following pages, the user will find sample coding forms for the second flight of path 8G and for path 8A, thus completing the landing flights for Runway 8. The quantities entered can be justified by referring to Forms 1, 3, and 4 for the appropriate flight path in the previous section.

On the folowing pages, the user will find sample coding forms for flights using flight paths 8B and 8C, thus completing the input for runway 8.

A comparison of the coding forms for flights 8 B 154, 8 B 151, and 8 B 161 will reveal that the only differences in these three sets of data reflect the information which varies from one aircraft type to another. That data which is a function of the flight path is identical in all three cases. The same is true of all subsequent flights on any flight path.

If the user wishes to consider more than 20 flights for any particular runway, he may, after entering the maximum number of flights, re-enter the runway information (coordinates, takeoff ground roll, and touchdown distance, and number of flights), followed by the additional flights. It should be noted, however, that two entries of the same runway count as two runways against the allowable maximum of ten.

At this point in the preparation of a complete data deck, the next runway would be entered in the same way as Runway 8 in the example just explained. Following the runway identification cards, sets of flight cards for all aircraft using that runway would be entered, arranged by flight paths.

The number of flights for each runway must not exceed 20 and must always equal the quantity entered opposite NOFLTS for that runway, and the number of extensions described for each flight must equal the quantity entered opposite NOEXTS for that flight.

To summarize the program restrictions once again, only zeroes (0.) may be entered for the Z-coordinates (ZCOORD) for any runway. The program provides for a maximum of ten runways (RUNWAY), and twenty flights (FLIGHT) per runway, but the total of all flights entered for the entire airport may not exceed 150. Each flight is allowed a maximum of seven extensions (EXTNSN), but the total number of extensions for all flights on all runways may not exceed 400.

GRID CARDS

After the information for all runways and flights has been entered, the grid which will contain the output must be defined. There is not a precise method for this operation; however, the user can accurately gather the information he needs from a diagram of his airport's runways and the ground projections of all flight paths, as illustrated in Figure 6 of Sample Airport.

FORTRAN CODING FORM

AUTHOR	PROGRAM NAME	PROGRAM NUMBER	DATE	PAGE OF

STATEMENT NO. | CONT | FORTRAN STATEMENT | IDENTIFICATION

```
FLIGHT                                  8 G 151
LANDNG
ACTYPE         151.
ACWGHT       65000.
THRUST          35.4
NDAYOP           8.
NEVNOP           2.
NNGTOP           6.
NOEXTS           2.
CLIMBA           3.
PRSEG1        1200.
PRSEG2        7100.
EXTNSN
EXTENT         170.
ELEVAT           3.
THRUST          35.4
RADIUS       -4000.
EXTNSN
EXTENT           0.
ELEVAT           3.
THRUST          35.4
RADIUS           0.
```

TSC F 1270.6

Flight 8G, 151

FORTRAN CODING FORM

AUTHOR | PROGRAM NAME | PROGRAM NUMBER | DATE | PAGE OF

STATEMENT NO. | CONT | FORTRAN STATEMENT | IDENTIFICATION

```
FLIGHT                                  8 A 154
LANDNG
ACTYPE        154.
ACWGHT      60000.
THRUST         42.
NDAYOP         26.4
NEVNOP          7.6
NNGTOP         11.
NOEXTS          0.
CLIMBA          3.
PRSEGI      12000.

FLIGHT                                  8 A 161
LANDNG
ACTYPE        161.
ACWGHT      43000.
THRUST         40.
NDAYOP         31.
NEVNOP          7.
NNGTOP          9.
NOEXTS          0.
CLIMBA          3.
PRSEGI      12000.
```

TSC F 1370.6

Flight 8A, 154

FORTRAN CODING FORM

AUTHOR	PROGRAM NAME	PROGRAM NUMBER	DATE	PAGE OF

STATEMENT NO. | CONT | FORTRAN STATEMENT → | IDENTIFICATION

```
FLIGHT                                  8 8 154
TAKOFF
ACTYPE        154.
ACWGHT      60000.
THRUST        100.
NDAYOP         21.2
DEVNOP          6.8
NNGTOP          6.
NOEXTS          2.
CLIMBA          8.92
PRSEG1       2000.
PRSEG2      15000.
EXTNSN
EXTENT         10.
ELEVAT          8.92
THRUST        100.
RADIUS       3000.
EXTNSN
EXTENT          0.
ELEVAT          8.92
THRUST        100.
RADIUS          0.
```

TSC F 1370.6

Flight 8B, 154

FORTRAN CODING FORM

AUTHOR | PROGRAM NAME | PROGRAM NUMBER | DATE | PAGE OF

STATEMENT NO. | CONT | FORTRAN STATEMENT | IDENTIFICATION

```
FLIGHT                                  8 B 151
TAKOFF
ACTYPE        151.
ACWGHT      65000.
THRUST        100.
NDAYOP          7.
NEVNOP          1.
NNGTOP          3.
NOEXTS          2.
CLIMBA          8.37
PRSEG1       1600.
PRSEG2      15400.
EXTNSN
EXTENT         10.
ELEVAT          8.37
THRUST        100.
RADIUS       3000.
EXTNSN
EXTENT          0.
ELEVAT          8.37
THRUST        100.
RADIUS          0.
```

TSC F 1370.6

Flight 8B, 151

FORTRAN CODING FORM

AUTHOR	PROGRAM NAME	PROGRAM NUMBER	DATE	PAGE OF

STATEMENT NO. | CONT | FORTRAN STATEMENT → | IDENTIFICATION

```
FLIGHT                                  8 B 161
TAKOFF
ACTYPE        161.
ACWGHT      43000.
THRUST        100.
NDAYOP         23.
NEVNOP          5.
NNGTOP          2.
NOEXTS          2.
CLIMBA          8.75
PRSEG1       1525.
PRSEG2      15475.
EXTNSN
EXTENT         10.
ELEVAT          8.75
THRUST        100.
RADIUS       3000.
EXTNSN
EXTENT          0.
ELEVAT          8.75
THRUST        100.
RADIUS          0.
```

TSC F 1370.6

Flight 8B, 161

FORTRAN CODING FORM

AUTHOR	PROGRAM NAME	PROGRAM NUMBER	DATE	PAGE OF

STATEMENT NO. | CONT | FORTRAN STATEMENT → | IDENTIFICATION

```
FLIGHT                                  8 C 154
TAKOFF
ACTYPE        154.
ACWGHT      60000.
THRUST        100.
NDAYOP          9.4
NEVNOP          4.6
NNGTOP          7.
NOEXTS          2.
CLIMBA          8.92
PRSEG1       2000.
PRSEG2      10000.
EXTNSN
EXTENT        170.
ELEVAT          8.92
THRUST        100.
RADIUS      -3000.
EXTNSN
EXTENT          0.
ELEVAT          8.92
THRUST        100.
RADIUS          0.
```

TSC F 1370.6

Flight 8C, 154

FORTRAN CODING FORM

AUTHOR | PROGRAM NAME | PROGRAM NUMBER | DATE | PAGE OF

STATEMENT NO. | CONT | FORTRAN STATEMENT | IDENTIFICATION

```
FLIGHT                                  8  C  151
TAKOFF
ACTYPE           151.
ACWGHT         65000.
THRUST           100.
NDAYOP             4.
NEVNOP             1.
NNGTOP             0.
NOEXTS             2.
CLIMBA             8.37
PRSEG1          1600.
PRSEG2         10400.
EXTNSN
EXTENT           170.
ELEVAT             8.37
THRUST           100.
RADIUS         -3000.
EXTNSN
EXTENT             0.
ELEVAT             8.37
THRUST           100.
RADIUS             0.
```

TSC F 1370.6

Flight 8C, 151

FORTRAN CODING FORM

AUTHOR	PROGRAM NAME	PROGRAM NUMBER	DATE	PAGE OF

STATEMENT NO. | CONT | FORTRAN STATEMENT → | IDENTIFICATION

```
FLIGHT                                  8 C  161
TAKOFF
ACTYPE         161.
ACWGHT       43000.
THRUST         100.
NDAYOP          10.
NEVNOP           3.
NNGTOP           4.
NOEXTS           2.
CLIMBA           8.75
PRSEG1        1525.
PRSEG2       10475.
EXTNSN
EXTENT         170.
ELEVAT           8.75
THRUST         100.
RADIUS       -3000.
EXTNSN
EXTENT           0.
ELEVAT           8.75
THRUST         100.
RADIUS           0.
```

TSC F 1370.6

Flight 8C, 161

The selection of a point of origin (0,0) has been explained in the previous section. Beginning with this same origin and using the same scale as was established for defining runways, the user should mark off points on both the X and Y axes, so as to include (on the X-Y grid) all points of the ground projections of all flight paths.

Referring to the established scale, the grid should now be extended three to four thousand meters (or feet) in every direction to make certain that it will accommodate adequate noise contours from each flight path. The only points it is actually necessary to define, however, are the largest and smallest points on the X and Y axes (largest positive X, smallest negative X, largest positive Y, smallest negative Y).

The increments between points on the X and Y axes must now be defined. Two things should be considered when selecting these quantities. First, there is a limit to the number of points which can be considered on each axis - 20 on the X axis and 25 on the Y. That is to say, the X increment must be sufficiently small to allow for a detailed contour, but large enough so as not to necessitate defining more than 20 points on the X axis. The same applies to the Y axis, however, 25 points may be computed here. Secondly, points lying on a runway should not be defined. In the case of the Sample Airport, for example, Runway 8 lies on the X-axis so the Y-increment must be chosen so that points on the X-axis Y=0 are not computed.

For purposes of input data, seven cards are necessary to define the points on the output grid: the X and Y coordinates of the point in the upper left corner so that X is negative and Y is positive, the X and Y increments, and the number of X's and number of Y's. A coding form demonstrating the correct format for inputting this information appears below.

FORTRAN CODING FORM

AUTHOR	PROGRAM NAME

C | STATEMENT NO. | CONT | FORTRAN STATEMENT →

```
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 ... 48
GRIDCL
FIRSTX     -32500.
FIRSTY      25500.
DELTAX       3000.
DELTAY      -3000.
NOOFXS         20.
NOOFYS         18.
```

GRIDCL	Identifies information to follow as defining the grid points to be computed.
FIRSTX	Initial X value or X-coordinate of the point in the uppermost left-hand corner of the grid, with mandatory decimal point in col. 18. This is the smallest X value and will probably be negative.
FIRSTY	Initial Y value or Y-coordinate of the point in the upper most left-hand corner of the grid, with mandatory decimal point in col. 18. This is the largest Y value and will probably be positive.
DELTAX	X-increment between grid points; this quantity will be positive, with mandatory decimal point in col. 18.
DELTAY	Y-increment between grid points; this quantity will be negative, with mandatory decimal point in col. 18.
NOOFXS	Number of X values, with mandatory decimal point in col. 18.
NOOFYS	Number of Y values, with mandatory decimal point in col. 18.

This data for defining the output grid is taken from Form 5 and must be included with each run.

PROCESSING CARDS

Following the grid information, a set of processing cards must be prepared and added to the deck. First, there is a PROCES card, followed by the user-supplied noise data if he chooses to enter his own instead of using that which is automatically supplied by the program. A discussion of the proper format for this data can be found in the following section. The card immediately after the PROCES card (or immediately following the noise data if it is included) contains the names of all runways defined for that airport in A8 format. That is, eight columns are allowed for each runway name, and the runways should be listed in the same order in which they appear in the input deck. The mandatory final instruction in the input deck are an ENDRUN card followed by a card indicating the noise contours to be plotted in 3F10.1 format, if a CALCOMP plot is part of the desired output. If a CALCOMP plot is not called for, the ENDRUN card will be last.

Below is a sample coding form completed for the processing cards for Sample Airport.

FORTRAN CODING FORM

AUTHOR | PROGRAM NAME

C | STATEMENT NO. | CONT | FORTRAN STATEMENT →

```
         1         2         3         4
123456789012345678901234567890123456789012345678
PROCES
8       21
ENDRUN
80.       85.       90.
```

PROCES	Mandatory instruction card.

If user is supplying his own noise tables, and a NOISIN card was included with the instruction cards in the beginning of the input deck, the noise values are inserted here.

8 21	Runways for Sample Airport in the same order in which they appear in the input deck in 10A8 format.
ENDRUN	Mandatory instruction card.
80. 85. 90.	Contours to be plotted in 3F10.1 format.

The program will accomodate up to three entries on the final contour card, punched beginning in columns 1, 11, and 21, with a mandatory decimal point. If he wishes less than 3 contours plotted, a 0. should be entered in the remaining field or fields. The user will select his contours based upon his desired interpretation of the results. The contours usually plotted for NE and NEF values are 30., 35., and 40.; and for WECPNL they are 80., 85., and 90.

It must be pointed out that if the user opts to access the aircraft noise model supplied by the NEM-5 program rather than supplying his own, his aircraft type numbers may be whole numbers from 1 to 12 only, corresponding to the classification shown in Appendix B of this document.

In the previous section, it was pointed out that the user could, if he wished, input his own EPNdB values for given distances for each aircraft type and thrust value instead of using the SAE noise tables contained in the program. The user-supplied noise input will be read only if the instruction card NOISIN is included with the option cards at the beginning of the data deck. The format for the user-supplied EPNdB values aned and distance curves and a sample coding form appear on the following two pages.

In this case, the user would assign his own aircraft type numbers to the classification in Appendix B, Table 1. The only restrictions are that his aircraft type numbers may not contain more then three digits, and that he use the same classification in the data deck and in the noise tables. The user must also be careful that a set of EPNdB values vs. distance curves is entered for each thrust value and aircraft type input in the data deck.

Following the sample coding form is a listing of the complete data deck for Sample Airport to provide an example for the user of correctly compiled data as it should be structured for use by the NEM-5 program: title cards, followed by the necessary option cards; runway and flight information, followed by the grid cards; process cards and optional noise data, and finally a contour card.

Format of User Entered EPNdB Values

(Each line corresponds to one card)

	Card Format
Number of sets of EPNdB vs distance curves	I10
Aircraft type number, Number of thrust curves for this type	I10, I10
Percent thrust, Takeoff/Landing, Arithmetic/Logarithmic+	F10.1, F10.1, F10.1
Number of pairs of coordinates	I10
Distance coordinates (in increasing order)*	8F10.1
Corresponding EPNdB coordinates*	8F10.1
Repetition of the four cards in brackets for each thrust curve corresponding to given Aircraft type number.	
Repetition of the cards in braces for each set.	

+Takeoff and Arithmetic scale are 0. Landing and Logarithmic scale are 1.

*Currently a maximum of 10 coordinates is permitted; if there are more than 8 coordinates, another card follows each of the indicated cards.

FORTRAN CODING FORM

AUTHOR	PROGRAM NAME	PROGRAM NUMBER	DATE	PAGE OF

STATEMENT NO. | CONT | FORTRAN STATEMENT → | IDENTIFICATION

```
         5
       111         2
100.      0.        1.
         6
400.      700.      1000.     4000.     10000.    50000.
116.9     113.1     110.3     94.7      84.7      66.9
60.7      1.        1.
         6
400.      700.      1000.     4000.     10000.    50000.
105.9     102.1     99.1      83.3      70.9      48.5

       134         2
100       0.        1.
         5
200.      400.      1000.     10000.    50000.
126.2     124.8     120.5     102.7     89.8
45.       1.        1.
         5
200.      400.      1000.     10000.    50000.
116.5     114.8     108.7     88.4      74.1
```

TSC F 1370.6

Sample Noise Data for Aircraft Types 111 and 134 for Sample Airport
1975

```
TITLEE
 SAMPLE AIRPORT 1975
MKSSYS
WECPNL
PRTALL
CLCMPS
NOISIN                                                  8
RUNWAY
XCOORD             0.0000         3000.000
YCOORD             0.0000            0.000
ZCOORD             0.0000            0.000
TKGDRL             0.0000
TCHDWN           300.0000
NOFLTS            10.                                   8 G 154
FLIGHT
LANDNG
ACTYPE           154.0000
ACWGHT         60000.0000
THRUST            42.0000
NDAYOP            12.
NEVNOP             2.
NNGTOP             2.
NOEXTS             2.0000
CLIMBA             3.0000
PRSEG1          1200.0000
PRSEG2          7100.0000
EXTNSN
EXTENT           170.0000
ELEVAT             3.0000
THRUST            42.0000
RADIUS         -4000.0000
EXTNSN
EXTENT             0.0000
ELEVAT             3.0000
THRUST            42.0000
RADIUS             0.0000                               8 G 151
FLIGHT
LANDNG
ACTYPE           151.
ACWGHT         65000.
THRUST            35.4
NDAYOP             8.
NEVNOP             2.
NNGTOP             6.
NOEXTS             2.
CLIMBA             3.
PRSEG1          1200.
PRSEG2          7100.
```

EXTNSN		
EXTENT	170.	
ELEVAT	3.	
THRUST	35.4	
RADIUS	-4000.	
EXTNSN		
EXTENT	0.	
ELEVAT	3.	
THRUST	35.4	
RADIUS	0.	
FLIGHT		8 A 154
LANDNG		
ACTYPE	154.0000	
ACWGHT	60000.0000	
THRUST	42.0000	
NDAYOP	26.4	
NEVNOP	7.6	
NNGTOP	11.	
NOEXTS	0.0000	
CLIMBA	3.0000	
PRSEG1	1200.0000	
FLIGHT		8 A 161
LANDNG		
ACTYPE	161.0000	
ACWGHT	43000.0000	
THRUST	40.0000	
NDAYOP	31.0000	
NEVNOP	7.0000	
NNGTOP	9.0000	
NOEXTS	0.0000	
CLIMBA	3.0000	
PRSEG1	1200.0000	
FLIGHT		8 B 154
TAKOFF		
ACTYPE	154.0000	
ACWGHT	60000.0000	
THRUST	100.0000	
NDAYOP	27.2	
NEVNOP	6.8	
NNGTOP	6.	
NOEXTS	2.0000	
CLIMBA	8.9200	
PRSEG1	2000.0000	
PRSEG2	15000.0000	
EXTNSN		
EXTENT	10.0000	
ELEVAT	8.9200	
THRUST	100.0000	
RADIUS	3000.0000	

EXTNSN		
EXTENT	0.0000	
ELEVAT	8.9200	
THRUST	100.0000	
RADIUS	0.0000	
FLIGHT		8 B 151
TAKOFF		
ACTYPE	151.0000	
ACWGHT	65000.0000	
THRUST	100.0000	
NDAYOP	7.	
NEVNOP	1.	
NNGTOP	3.	
NOEXTS	2.0000	
CLIMBA	8.3700	
PRSEG1	1600.0000	
PRSEG2	15400.0000	
EXTNSN		
EXTENT	10.0000	
ELEVAT	8.3700	
THRUST	100.0000	
RADIUS	3000.0000	
EXTNSN		
EXTENT	0.0000	
ELEVAT	8.3700	
THRUST	100.0000	
RADIUS	0.0000	
FLIGHT		8 B 161
TAKOFF		
ACTYPE	161.0000	
ACWGHT	43000.0000	
THRUST	100.0000	
NDAYOP	23.0000	
NEVNOP	5.0000	
NNGTOP	2.0000	
NOEXTS	2.0000	
CLIMBA	8.7500	
PRSEG1	1525.0000	
PRSEG2	15475.0000	
EXTNSN		
EXTENT	10.0000	
ELEVAT	8.7500	
THRUST	100.0000	
RADIUS	3000.0000	
EXTNSN		
EXTENT	0.0000	
ELEVAT	8.7500	
THRUST	100.0000	
RADIUS	0.0000	

FLIGHT		8 C 154
TAKOFF		
ACTYPE	154.0000	
ACWGHT	60000.0000	
THRUST	100.0000	
NDAYOP	9.4	
NEVNOP	4.6	
NNGTOP	7.	
NOEXTS	2.0000	
CLIMBA	8.9200	
PRSEG1	2000.0000	
PRSEG2	10000.0000	
EXTNSN		
EXTENT	170.0000	
ELEVAT	8.9200	
THRUST	100.0000	
RADIUS	-3000.0000	
EXTNSN		
EXTENT	0.0000	
ELEVAT	8.9200	
THRUST	100.0000	
RADIUS	0.0000	
FLIGHT		8 C 151
TAKOFF		
ACTYPE	151.0000	
ACWGHT	65000.0000	
THRUST	100.0000	
NDAYOP	4.	
NEVNOP	1.	
NNGTOP	0.	
NOEXTS	2.0000	
CLIMBA	8.3700	
PRSEG1	1600.0000	
PRSEG2	10400.0000	
EXTNSN		
EXTENT	170.0000	
ELEVAT	8.3700	
THRUST	100.0000	
RADIUS	-3000.0000	
EXTNSN		
EXTENT	0.0000	
ELEVAT	8.3700	
THRUST	100.0000	
RADIUS	0.0000	
FLIGHT		8 C 161
TAKOFF		
ACTYPE	161.0000	
ACWGHT	43000.0000	
THRUST	100.0000	

```
NDAYOP          10.0000
NEVNOP           3.0000
NNGTOP           4.0000
NOFXTS           2.0000
CLIMBA           8.7500
PRSEG1        1525.0000
PRSEG2       10475.0000
EXTNSN
EXTENT         170.0000
ELEVAT           8.7500
THRUST         100.0000
RADIUS       -3000.0000
EXTNSN
EXTENT           0.0000
ELEVAT           8.7500
THRUST         100.0000
RADIUS           0.0000
RUNWAY                                          21
XCOORD        3000.0000          500.000
YCOORD        1000.0000        -2000.000
ZCOORD           0.0000            0.000
TKGDRL           0.0000
TCHDWN         300.0000
NOFLTS           6.0000
FLIGHT                                          21 D 111
LANDNG
ACTYPE         111.0000
ACWGHT      350000.0000
THRUST          60.7000
NDAYOP           6.0000
NEVNOP           1.0000
NNGTOP           2.0000
NOFXTS           0.0000
CLIMBA           3.0000
PRSEG1        2000.0000
FLIGHT                                          21 D 134
LANDNG
ACTYPE         134.0000
ACWGHT      100000.0000
THRUST          45.0000
NDAYOP          31.0000
NEVNOP           7.0000
NNGTOP          21.0000
NOFXTS           0.0000
CLIMBA           3.0000
PRSEG1        1500.0000
FLIGHT                                          21 F 111
TAKOFF
ACTYPE         111.0000
ACWGHT      350000.0000
THRUST         100.0000
```

NDAYOP	5.0000	
NEVNOP	1.0000	
NNGTOP	1.0000	
NOEXTS	2.0000	
CLIMBA	4.9200	
PRSEG1	3350.0000	
PRSEG2	8650.0000	
EXTNSN		
EXTENT	60.0000	
ELEVAT	4.9200	
THRUST	100.0000	
RADIUS	4000.0000	
EXTNSN		
EXTENT	0.0000	
ELEVAT	4.9200	
THRUST	100.0000	
RADIUS	0.0000	
FLIGHT		21 F 134
TAKOFF		
ACTYPE	134.0000	
ACWGHT	100000.0000	
THRUST	100.0000	
NDAYOP	19.2000	
NEVNOP	4.8000	
NNGTOP	11.0000	
NOEXTS	2.0000	
CLIMBA	14.7300	
PRSEG1	1300.0000	
PRSEG2	10700.0000	
EXTNSN		
EXTENT	60.0000	
ELEVAT	14.7300	
THRUST	100.0000	
RADIUS	4000.0000	
EXTNSN		
EXTENT	0.0000	
ELEVAT	14.7300	
THRUST	100.0000	
RADIUS	0.0000	
FLIGHT		21 F 111
TAKOFF		
ACTYPE	111.0000	
ACWGHT	350000.0000	
THRUST	100.0000	
NDAYOP	1.6000	
NEVNOP	0.4000	
NNGTOP	0.0000	
NOEXTS	2.0000	
CLIMBA	4.9200	
PRSEG1	3350.0000	
PRSEG2	8650.0000	

```
EXTNSN
EXTENT          120.0000
ELEVAT            4.9200
THRUST          100.0000
RADIUS        -4000.0000
EXTNSN
EXTENT            0.0000
ELEVAT            4.9200
THRUST          100.0000
RADIUS            0.0000
FLIGHT                                          21 F 134
TAKOFF
ACTYPE          134.0000
ACWGHT       100000.0000
THRUST          100.0000
NDAYOP           15.0000
NEVNOP            4.0000
NNGTOP            5.0000
NOEXTS            2.0000
CLIMBA           14.7300
PRSEG1         1300.0000
PRSEG2        10700.0000
EXTNSN
EXTENT          120.0000
ELEVAT           14.7300
THRUST          100.0000
RADIUS        -4000.0000
EXTNSN
EXTENT            0.0000
ELEVAT           14.7300
THRUST          100.0000
RADIUS            0.0000
GRIDCL

DELTAX        3000.
DELTAY       -3000.
NOOFXS          20.
NOOFYS          18.
FIRSTX      -32500.
FIRSTY       25500.
PROCES
```

	5				
	111	2			
100.	0.	1.			
	6				
400.	700.	1000.	4000.	10000.	50000.
116.9	113.1	110.3	94.7	84.7	66.9
60.7	1.	1.			
	6				
400.	700.	1000.	4000.	10000.	50000.
105.9	102.1	99.1	83.3	70.9	48.5
	134	2			
100.	0.	1.			
	5				
200.	400.	1000.	10000.	50000.	
126.2	124.8	120.5	102.7	89.8	
45.0	1.	1.			
	5				
200.	400.	1000.	10000.	50000.	
116.5	114.8	108.7	88.4	74.1	
	151	2			
100.	0.	1.			
	6				
400.	1000.	2000.	4000.	10000.	50000.
116.7	110.2	105.0	99.2	91.6	78.4
35.4	1.	1.			
	6				
400.	1000.	2000.	4000.	10000.	40000.
104.7	96.2	88.6	79.9	67.8	50.0
	154	2			
100.	0.	1.			
	5				
200.	400.	1000.	10000.	50000.	
123.5	118.8	112.6	99.0	87.1	
42.0	1.	1.			
	5				
200.	400.	1000.	10000.	50000.	
114.1	110.2	105.0	92.5	83.5	
	161	2			
100.	0.	1.			
	6				
250.	500.	1000.	2000.	8000.	50000.
119.5	114.4	109.0	103.0	86.0	60.0
40.0	1.	1.			
	6				
250.	500.	1000.	2000.	8000.	50000.
112.2	107.0	100.3	93.0	75.0	51.4
8	21				
ENDRUN					
80.	85.	90.		386	

WRITING SOURCE AND BINARY DECKS ONTO TAPE

The following control cards are needed to place the MOD 5 source deck as file 1 and the corresponding binary deck as file 2 onto a 7-track tape for processing on the 360/75. The actual placing onto tape can be done on the 360/30.

```
col                                                                col
 1                                                                  72

//CDTP JOB JONES

//STEP1 EXEC PGM=IEBGENER

//SYSPRINT DD SYSOUT=A

//SYSIN DD DUMMY

//SYSUT2 DD DSNAME=SORCSET,UNIT=2400-2,LABEL=(1,NL),
  DISP=(NEW,PASS),                                                  X

//             VOLUME=SER=DT1720,DCB=(RECFM=FB,LRECL=80,
               BLKSIZE=800,                                         X

//             DEN=2,TRTCH=C)

//SYSUT1 DD *

  MOD 5 Source deck goes here

/*

//STEP2 EXEC PGM=IEBGENER

//SYSPRINT DD SYSOUT=A

//SYSIN DD DUMMY

//SYSUT2 DD DSNAME=LOADSET,UNIT=2400-2,LABEL=(2,NL),
  DISP=(NEW,KEEP),                                                  X

//             VOLUME=SER=DT1720,DCB=(RECFM=FB,LRECL=80,
               BLKSIZE=800,                                         X

//             DEN=2,TRTCH=C)

//SYSUT1 DD*

  MOD 5 binary deck goes here

/*
```

EXECUTING PROGRAM FROM TAPE

The following control cards are needed to execute the MOD 5 binary program from file 2 of the program. The program tape is DT1720.

```
col                                                                    col
 1                                                                      72

//JONES    JOB 4390,DOT,TIME=05,REGION=300K

//STEP1 EXEC FORTHLG

//LKED.SYSIN   DD UNIT=TAPE7,DSNAME=LOADSET,LABEL=
  (2,NL),DISP=(OLD,                                                      X

//             KEEP),VOLUME=SER=DT1720,DCB=(RECFM=FB,
               LRECL=80,                                                 X

//             BLKSIZE=800,DEN=2,TRTCH=C)

//GO.PLOTTER   DD UNIT=TAPE7,DSN=PLOT,LABEL=(,BLP),
  VOLUME=SER=PLOTCX,                                                     X

//             DISP=(OLD,KEEP), DCB=(DEN=2)

//GO.SYSUDUMP  DD SYSOUT=A

//GO.SYSIN     DD*

  Input instruction/data go here

/*

//

/*
```

APPENDIX A

NOISE EXPOSURE MODEL

MOD 5 ANALYSIS FORMS

FORM 1

AIRCRAFT CLASS		Gross Weight	Length of Takeoff Roll	Initial Climb Angle	Percent Thrust	Length of Landing Roll	Final Descent Angle	Percent Thrust
Type No.	Profile							

☐ FEET/POUNDS

☐ METERS/KILOGRAMS

Figure A-1. Form 1

FORM 2

	A Beginning of Runway	D End of Runway	Runway Name
x (coordinates)			
y (coordinates)			
z (coordinates)			
TKGDRL Start of take off roll (AC)			
TCHDWN Touchdown Distance (AB) from point A			

☐ FEET/POUNDS

☐ METERS/KILOGRAMS

Figure A-2. Runway Coordinate Data

FORM 3A

Runway____________

Ground Track	Number of Extensions	Segments 1 and 2	Extension 1 Length or Radius	Extension 1 Turn Angle	Extension 2 Length or Radius	Extension 2 Turn Angle

☐ FEET/POUNDS

☐ METERS/KILOGRAMS

Figure A-3. Airport Ground Track Data Form

FORM 3B

Runway____________

Ground Track	Extension 3 Length or Radius	Extension 3 Turn Angle	Extension 4 Length or Radius	Extension 4 Turn Angle	Extension 5 Length or Radius	Extension 5 Turn Angle	Extension 6 Length or Radius	Extension 6 Turn Angle	Extension 7 Length or Radius	Extension 7 Turn Angle

☐ FEET/POUNDS
☐ METERS/KILOGRAMS

Figure A-4. Airport Ground Track Data Continuation Form

FORM 4A

Runway________________

Ground Track	Aircraft Class		Landing or Takeoff	Number of Operations			Length of Segment 2	Extension 1		Extension 2	
	Type No.	Profile		Day	Eve.	Night		Thrust	Angle in Degrees	Thrust	Angle in Degrees

☐ FEET/POUNDS

☐ METERS/KILOGRAMS

Figure A-5. Flight Model Data

FORM 4B

Runway__________________

Flight Model Designation	Extension 3		Extension 4		Extension 5		Extension 6		Extension 7	
	Thrust	Angle in Degrees	Thrust	Angle in Degrees	Thrust	Angle in Degrees	Thrust	Angle in Degrees	Thrust	Angle in Degrees

☐ FEET/POUNDS

☐ METERS/KILOGRAMS

Figure A-6. Flight Model Data Continuation Form

FORM 5

NOISE EXPOSURE INDEX TO BE CALCULATED

- [ ] NE
- [ ] NEF
- [ ] WECPNL

OBSERVER'S GRID FOR NOISE EXPOSURE INDEX CALCULATION

x_o	
y_o	
Δx	
Δy	
Nx	
Ny	

NOISE EXPOSURE INDEX CONTOUR VALUES

1	
2	
3	

Figure A-7. Noise Exposure Index Model Information

APPENDIX B

TABLES OF AIRCRAFT
CHARACTERISTICS OF NEM-5
PROGRAM

Appendix B is composed of 2 tables to acquaint the user with the aircraft characteristics written into the NEM-5 program. Table B-1 gives a description of each aircraft type, classified by number and type of engines. For use by the NEM-5 program, the various aircraft types are grouped into flight profiles (AA, A, B, C, D, E), based upon their takeoff gross weights. The initial climb angle (CLIMBA) and the length of the first segment of flight (PRSEG1) are functions of the profile and are listed in Table B-2.

If the user opts to use those values assigned by the NEM-5 program each entry for an aircraft type (ACTYPE) in his data deck must be a whole number from one to twelve as defined in Table B-1.

TABLE B-1

Aircraft Type	Profile: Takeoff gross weight in thousands of pounds					
	AA	A	B	C	D	E
Airline Transport Aircrafts						
1 4 engine HBPR turbofans	N/A	N/A	400 to 500	500 to 605	605 to 710	710 to 800
2 3 engine HBPR turbofans	N/A	200 to 250	250 to 300	300 to 350	350 to 400	400 to 450
3 4 engine LBPR turbofans	N/A	200 to 215	215 to 250	250 to 280	280 to 315	315 to 350
4 4 engine turbojets	N/A	N/A	200 to 220	220 to 250	250 to 275	275 to 305
5 3 engine LBPR turbofans	N/A	100 to 115	115 to 135	135 to 150	150 to 170	N/A
6 2 engine LBPR turbofans	N/A	60 to 80	80 to 100	100 to 120	N/A	N/A
General Aviation Aircraft and Small Transports	AA	A	B	C	D	E
7 2 engine LBPR turbofans	40 to 50	50 to 60	N/A	N/A	N/A	N/A
8 4 engine turbojets	24 to	31.5 to 38.5	38.5 to 42	N/A	N/A	N/A
9 2 engine LBPR turbofans	16 to 20	20 to 25	25 to 30	N/A	N/A	N/A
10 2 engine turbojets	up to 12	12 to 15	N/A	N/A	N/A	N/A
11 2 engine props						
12 4 engine props						
13 Supersonic transport	400 to 450	450 to 575	575 to 675	N/A	N/A	N/A

TABLE B-2

Profile	Initial Climb Angle	Length of First Flight Segment Feet	Length of First Flight Segment Meters
AA	18.4°	2550	780
A	11.8°	4000	1220
B	9.6°	5500	1675
C	7.6°	6800	2070
D	6.0°	9200	2800
E	5.0°	10600	3230
2 engine prop	5.1°	2800	850
4 engine prop	5.1°	2800	850

APPENDIX C

DATA DECK GENERATOR

DATA DECK GENERATOR

This appendix describes a program which takes prespecified input and generates a deck of cards for use in the Noise Exposure Model 5 (NEM-5) calculations. This "Deck Generator" (DG) is a Fortran IV program written for and operable on the IBM 7094 at TSC. The input to this DG is more structured than the NEM-5 data deck and arranged in a tabular fashion. The program does all necessary multiplication, scaling as needed, and provides all necessary header cards. However, it does not provide the few option cards which appear at the front or back of the NEM-5 program.

On the average, 140 data cards of DG input will produce 2000 cards of data.

The input is structured so that general information is read in first. This is followed by runway information, then all flight path, aircraft type, and extension information associated with that runway. After completing all information for one runway, it proceeds again to read more runway information and all flight path, aircraft type, and extension information concentrated with it. The program continues in this way until it has read and processed as many runways and associated data as input by the general information cards. It then stops.

The general information consists of:

1. the number of runways to be processed
2. the total number of operations or all aircraft (A/C) used
3. a scale or multiplication factor, and
4. aircraft characteristics.

Although no restriction is imposed by the DG on the number of runways to be processed it is desirable to set up calculations so that cards for 10 or fewer runways are produced, since the NEM-5 program cannot handle more than 10 of them. Three other restrictions should be kept in mind so as to insure that the output of the DG is useful in the NEM-5 program. First only zeroes(0.) may be entered for the Z-coordinates (ZCOORD) for any runway. The NEM-5 program provides for a maximum of ten runways (RUNWAY) and twenty flights(FLIGHT) per runway, but the total of all flights entered for the entire airport may not exceed 150. Finally, each flight is allowed a maximum of seven extensions(EXTNSN), but the total number of extensions for all flights on all runways may not exceed 400.

The total number of aircraft (A/C) used would be given by 100 if the "day, evening, night" were allocated by "Preferred Runway Utilization". However, for "percentage" distribution the total number of A/C would be an absolute number.

The scale factor is simply a multiplier, so that one can input measurements from a drawing and have them multiplied to give runway coordinates in absolute units.

Aircraft characteristics for all aircraft to be used both in takeoff and landings are also entered as part of the general information. These characteristics include (1) weight, (2) thrust, (3) type, (4) percentage of day, evening, or night operations if percentage runway utilization is desired, (5) length of takeoff or landing ground roll, and (6) initial climb or descent angle.

After the general information the program reads through as many sets of concatenated data as entered on the number of runway cards in the general information set. The first entry in each of these sets gives the runway name and number of distinct paths emanating from this runway. The next entry will be a flight path card which gives (1) flight path name, (2) landing or takeoff, (3) percentage utilization, (4) number of aircrafts flying this path, (5) number of extensions (or segments beyond the one after end of takeoff ground roll or beginning of landing ground roll), and (6) the length from beginning of runway to start of the first extension. After the flight path has been entered the program seeks N aircraft type cards, and M extension cards, as explained in the following paragraphs.

Types of aircraft flown on this path are entered just after flight path information. The amount and kind of information given here depend upon the type of runway utilization assumed.

If preferred runway utilization is desired then each set of aircraft type-information is entered with the number of day, evening, and night operations. These are multiplied with the percent flight path utilization number and total number of aircraft to give the number of day, evening and night operations. With this choice it is necessary to express both the total number of aircraft and the percent flight path utilization as 100%. These numbers are multiplied by 10^{-4} internally so that an absolute value of day, night, or evening operations may be entered, punched, and printed out.

If percentage runway utilization is desired then aircraft type information is entered without* the number of day, evening, or night operations. Instead this information is entered as a percentage in the aircraft characteristic cards. In turn this number is multiplied by the total number of aircraft, (this time expressed as an absolute number), and the percent flight path utilization. As before this product is offset by 10^{-4} internally so that two of three numbers must be expressed as percentages while the third (total number of aircraft) is entered as an absolute number.

For either type of calculation the total number of operations is summed for each flight path and appears on the print out, but not in the final punched deck. Thus it is possible to check the allocation of A/C by adding all sums for takeoffs and compare with the same kind of total for landings.

The arrangement of input cards for the DG is illustrated by the listing which follows. Comments relevant to this list are offset by a border. They serve to explain the parts of the list but are not themselves part of it. Card format is an important part of these comments; other parts should be self explanatory.

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*If the number of day, evening, or night operations do not appear on the aircraft type cards then the program prints out and punches the results of the other product.

$DATA. PRECEDES DATA SET

2	Number of runways, (I3 Format)
100.	Number of aircraft, (F10.4 Format)
1.	Scale factor, (F10.4 Format)

AIRCRAFT CHARACTERISTICS CARDS (40 CARDS, 8F10.4 FORMAT)

Aircraft Weight	Aircraft Thrust	Aircraft Type	Number or % of day operations	Number or % of evening operations	Number or % of night operations	Length of Tradeoff or Landing Roll	Initial Climb or Final Descent Angle
350000.	100.	111.	0.	0.	0.	3350.	4.9
120000.	100.	124.				1250.	11.8
150000.	100.	131.				3050.	4.7
150000.	100.	132.				3050.	4.2
150000.	100.	133.				3050.	3.7
100000.	100.	134.	0.	0.	0.	1300.	14.7
120000.	100.	141.				2200.	6.7
65000.	100.	151.				1600.	8.3
65000.	100.	152.				1600.	8.3
65000.	100.	153.				1800.	6.9
60000.	100.	154.				2000.	8.9
60000.	100.	156.				2000.	8.9
43000.	100.	161.				1525.	8.7
43000.	100.	162.				1425.	8.6
43000.	100.	163.				1575.	8.4
44000.	100.	167.				1700.	7.6
44000.	100.	169.				1850.	7.3
48000.	100.	171.				2100.	8.5
9000.	100.	191.				1200.	11.7
9000.	100.	192.				850.	5.1

For Preferred Runway utilization enter 0. in these columns or leave blank

$DATA. PRECEDES DATA SET

2		Number of runways, (I3 Format)
	100.	Number of aircraft, (F10.4 Format)
	1.	Scale factor, (F10.4 Format)

AIRCRAFT CHARACTERISTICS CARDS (40 CARDS, 8F10.4 FORMAT)

Aircraft Weight	Aircraft Thrust	Aircraft Type	Number or % of day operations	Number or % of evening operations	Number or % of night operations	Length of Tradeoff or Landing Roll	Initial Climb or Final Descent Angle
350000.	60.7	111.	0.	0.	0.	2000	3.0
120000.	45.0	124.				1500.	3.0
150000.	44.8	131.				1500.	3.0
150000.	45.4	132.				1500.	3.0
150000.	45.7	133.				1500.	3.0
100000.	45.	134.	0.	0.	0.	1500.	3.0
120000.	35.	141.				1500.	3.0
65000.	35.4	151.				1200.	3.0
65000.	35.8	152.				1200.	3.0
65000.	38.9	153.				1200.	3.0
60000.	42.00	154.				1200.	3.0
60000.	42.00	156.				1200.	3.0
43000.	40.00	161.				1200.	3.0
43000.	38.00	162.				1200.	3.0
43000.	36.00	163.				1200.	3.0
44000.	41.00	167.				1200.	3.0
44000.	41.00	169.				1200.	3.0
48000.	45.00	171.				1200.	3.0
9000.	45.	191.				1200.	3.0
9000.	45.	192.				1200.	3.0

RUNWAY NAME - COORDINATE CARDS (6 CARDS, FORMATS AS SHOWN)

RUNWAY Name A6 FORMAT	NUMBER OF Flight Paths I3 FORMAT last digit column 9		
8	0.4	3000.	First and Second X Coordinate (2F 10.4 Format)
	0.	0.	First and Second Y Coordinate (2F 10.4 Format)
	0.	0.	First and Second Z Coordinate (2F 10.4 Format)
	0.		Distance to Start of takeoff ground roll (1F 10.4 Format)
	300.		Distance to Start of landing ground roll (1F 10.4 Format)

FLIGHT PATH CARD (1 Card Formats as shown)

FLIGHT PATH NAME (A6 FORMAT STARTING IN COLUMN 1)	TAKEOFF OR LANDING (A6 FORMAT STARTING IN COLUMN 11)	RUNWAY UTILIZATION. ENTER 100. or PERCENTAGE SEE TEXT. (F10.4 FORMAT STARTING IN COLUMN 21)	NUMBER OF FLIGHTS (F10.4 FORMAT STARTING IN COLUMN 31)	NUMBER OF EXTENSIONS (F10.4 FORMAT STARTING IN COLUMN 31)	DISTANCE FROM START OF RUNWAY TO START OF FIRST EXTENSION. (F10.4 FORMAT STARTING COLUMN 51)
8G	LANDNG	100.	2.	2.	8300.

AIRCRAFT OPERATIONS CARDS
(Number of cards equal to number of FLIGHTS, 4F10.4 FORMAT

AIRCRAFT TYPE	NUMBER OF DAY OPERATIONS	NUMBER OF EVENING OPERATIONS	NUMBER OF NIGHT OPERATIONS
154.	12.	2.	2.
151.	8.	2.	6.

FLIGHT PATH EXTENSION CARDS
(Number of cards equal to number of extensions, 2F10.4 FORMAT

Angle of turn or length of straight path	Radius of curved segment. Otherwise 0.
170.	-4000.
0.	0.

REMAINING DATA CARDS

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8A              LANDNG       100.        2.        0.
     154.         26.4         7.6      11.
     161.         31.          7.        9.
8B              TAKOFF       100.        3.        2.        17000.
     154.         27.2         6.8       6.
     151.          7.          1.        3.
     161.         23.          5.        2.
      10.       3000.
       0.          0.
8C              TAKOFF       100.        3.        2.        12000.
     154.          9.4         4.6       7.
     151.          4.          1.        0.
     161.         10.          3.        4.
     170.      -3000.
       0.          0.
21      3
    3000.        500.
    1000.      -2000.
       0.          0.
       0.
     300.
21D             LANDNG       100.        2.        0.        12000.
     111.          6.          1.        2.
     134.         31.          7.       21.
21E             TAKOFF       100.        2.        2.        12000.
     111.          5.          1.        1.
     134.         19.2         4.8      11.
      60.       4000.
       0.          0.
21F             TAKOFF       100.        2.        2.        12000.
     111.          1.6          .40      0.
     134.         15.          4.        5.
     120.      -4000.
       0.          0.
'      END OF FILE CARD
'      END OF FILE CARD
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