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16. Abstract

This document contains instructions to execute the Area Equivalent Method (AEM). The AEM requires the LOTUS 1-2-3 software package and an IBM personal computer or a calculator.

The Area equivalent Method is a mathematical process to calculate Day Night Average Sound Level (DNL) contour area. The AEM is easy to use and is intended as a screening procedure to determine the need for an airport Environmental Impact Statement (EIS). This document is the second in a series of reports on the AEM. The first report was titled "Area Equivalent Method on VISICALC@'"' (Report No. FAA-EE-84-8).

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The Area Equivalent Method (AEM) was originally developed for the Environmental and Energy Programs Division, Office of Economic Analysis of the Civil Aeronautics Board (CAB). CAB wanted a quick way to determine airport Noise Exposure Forecast (NEF) contour area. The firm of J. Watson Noah Inc. created the original versions of AEM for computer, programmable calculator and pencil and paper (Reference 1). The AEM described within this report draws upon the techniques developed by J. Watson Noah Inc. with updated parameters to calculate Day Night Average Sound Level (DNL) contours.

TABLE OF CONTENTS

		PAGE
1.0	INTRODUCTION	1-1
2.0	DESCRIPTION	2-1
3.0	DEVELOPMENT	3-1
4.0	LOTUS 1-2-3 METHOD	4-1
4.1	Instructions	4-1
5.0	CALCULATOR METHOD	5-1
5.1	Instructions	5-1
APPENDIX A:	AVAILABILITY OF AEM ON LOTUS 1-2-3	A-1
APPENDIX B:	AEM ON LOTUS 1-2-3 LISTING	B-1
APPENDIX C:	REFERENCES	C-1

LIST OF FIGURES

		PAGE
3-1	EXAMPLE OF AEM LINEAR REGRESSION EQUATIONS	3-2
4-1	DNLAEM, THE AEM LOTUS 1-2-3 TEMPLATE	4-2
4-2	DNLAEM FILLIN FORMAT	4-3
4-3	EXAMPLE OF AEM 65 LDN OUTPUT FROM LOTUS 1-2-3	4-4
4-4	EXAMPLE OF AEM 75 LDN OUTPUT FROM LOTUS 1-2-3	4-5
5-1	AEM CALCULATOR METHOD WORKSHEET	5-3

LIST OF TABLES

		PAGE
3-1	AEM PARAMETERS AND CORRELATION COEFFICIENTS.....	3-3
B-l	LOCATIONS OF A AND B PARAMETERS ON AEM TEMPLATE.....	B-4
B-2	LOCATIONS OF AIRCRAFT NAMES AND IDENTITIES ON AEM TEMPLATE. . . . ..a.....	B-5

1.0 INTRODUCTION

The Area Equivalent Method is a mathematical procedure that provides the noise contour area of a specific airport given the types of aircraft and the number of operations for each aircraft. 'The noise contour area is a measure of the size of the land mass enclosed within a level of noise as produced by a given set of aircraft operations.

The noise contour metric is the Day, Night Average Sound Level (DNL) which provides a single quantitative rating of a noise level over a 24-hour period. This rating involves a 10 decibel penalty to aircraft operations during nighttime (between 10pm and 7am) to account for the increased annoyance in the community.

The AEM produces contour areas (in square miles) for levels of 65 and 75 L_{dn}. The AEM is used to develop insights as to the noise impact of an airport on its surrounding communities, as well as the potential increase or decrease of noise resulting from a change in aircraft operations. The AEM is a useful screening tool in airport planning and development.

The following text will provide a more detailed explanation of the ABM as well as instructions for use of the AEM on the IBM® Personal Computer, IBM/XT™, or COMPAQ™ using the LOTUS 1-2-3™ software program. Instructions on the ABM calculator method are also included.

2.0 DESCRIPTION

According to FAA Order 1050.1D, "Policies and Procedures for Considering Environmental Impacts," an assessment must be made to determine the noise impact of a proposed airport action. This assessment compares the present noise impact on the environment with that of the proposed change. If the noise impact is significant then the FAA requires an Environmental Impact Statement (EIS). If the increase of noise impact on the community is not significant then the FAA prepares a Finding of No Significant Impact (FONSI), which briefly outlines the specifications of the change in airport operations for that particular airport.

An Environmental Impact Statement is a long and involved process which requires use of an airport noise computer model such as the Integrated Noise Model (INM). The INM is a complex and detailed procedure which determines the DNL noise contour area for a specific mix of aircraft, and plots the contour lines relative to runway configuration. The INM is a useful procedure for airport planners, airport operators and local governments in assessing the noise impact to the community around an airport. The INM offers the capability to analyze several operational controls beyond simply changing aircraft mix. The INM is the most appropriate tool for EIS, Airport Noise Control and Land Use Compatability (ANCLUC), Part 150 and other federally funded airport environmental studies.

The Civil Aeronautics Board (CAB) developed the Noise Screening Methodology to decide whether the noise impact due to a change is significant. CAB promulgated this noise screening procedure in 14 CFR 312, Appendix I. It is commonly called the "CAB Procedure." CAB established a decision criterion of 17% increase in cumulative noise contour area. If the percentage difference due to the change is less than 17%, no further study is necessary. A 17% increase in cumulative noise contour area translates into a one decibel increase in the airport noise. The Area Equivalent Method (AEM) is an outgrowth of the CAB Procedure. In Advisory Circular 150/5020-3 "Noise Impact Initial Screening Procedure," the FAA applies the same decision criterion to AEM as the CAB did with the Noise Screening Methodology.

The AEM is a screening procedure used to simplify the assessment step in determining the need for an EIS. The purpose of the AEM is to show change in airport DNL noise contour area relative to a change in aircraft mix and number of operations. The AEM determines the DNL noise contour area in square miles for a mix and number of aircraft types. The basis of AEM is the equation which determines the DNL noise contour area as a function of the number of daily operations. The AEM applies parameters derived from INM output to determine a contour area for each aircraft. The AEM then develops a single equation, representing the specific mix and number of aircraft to produce the contour area for an airport. The contour area produced by the AEM approximates the contour area produced by the INM for a particular airport case.

3.0 DEVELOPMENT

The AEM determines the Day Night Average Sound Level (DNL) noise contour area (insquare miles) for a specific case of aircraft operations, given the mix of aircraft types and the number of landing-takeoff cycles (LTOs) per aircraft. In order to create the AEM, aircraft specific parameters relating DNL noise contour area to LTOs were derived from INM output for 65 and 75 L_{dn}. These parameters, represented by the variables a and b, are constants which produce the 65 or 75 L_{dn} contour area due to a specific number of operations of an aircraft from the following equation:

$$A = aN^b$$

The constant a is the noise contour area in square miles of a single LTO for an aircraft. The constant b is a scaling parameter which determines the change in contour area relative to a change in the number of effective LTOs for an aircraft. The noise contour area, A, is the result of applying the parameters a and b to N, the number of effective LTOs. The number of effective LTOs is the sum of the daytime LTOs and the nighttime LTOs of an aircraft. The nighttime LTOs are weighted by a multiple of 10 due to the added amount of annoyance to the community during the nighttime hours between 10pm and 7am.

The Integrated Noise Model (INM) Version 3.8 was used to produce aircraft noise contour areas for specific numbers of LTOs. INM was run for each of the 66 aircraft in the INM Version 3.8 data base. The parameters a and b are determined from the linear regression equation:

$$\log A = \log a + b \log N$$

Figure 3-1 illustrates the linear regression lines derived from this logarithmic equation for each L_{dn}. The INM produced the contour areas as shown by the symbols ⊡ and △. The graph is based on a log - log relationship between the contour area in square miles and the number of LTOs of an aircraft at different values of L_{dn}. Below each regression line on the graph is the equation of that line and a value for the correlation coefficient. The equation is the linear transformation of the logarithmic equation with the parameters a and b and N:

$$A = aN^b$$

The correlation coefficient, r, indicates how well the regression line represents the relationship of contour area to a, b and N. An r value of 1.000 indicates a perfect correlation between the equation and the calculated contour areas for that L_{dn}. The parameters and correlation coefficients for all 66 aircraft in the INM Data Base #8 are given in Table 3.1.

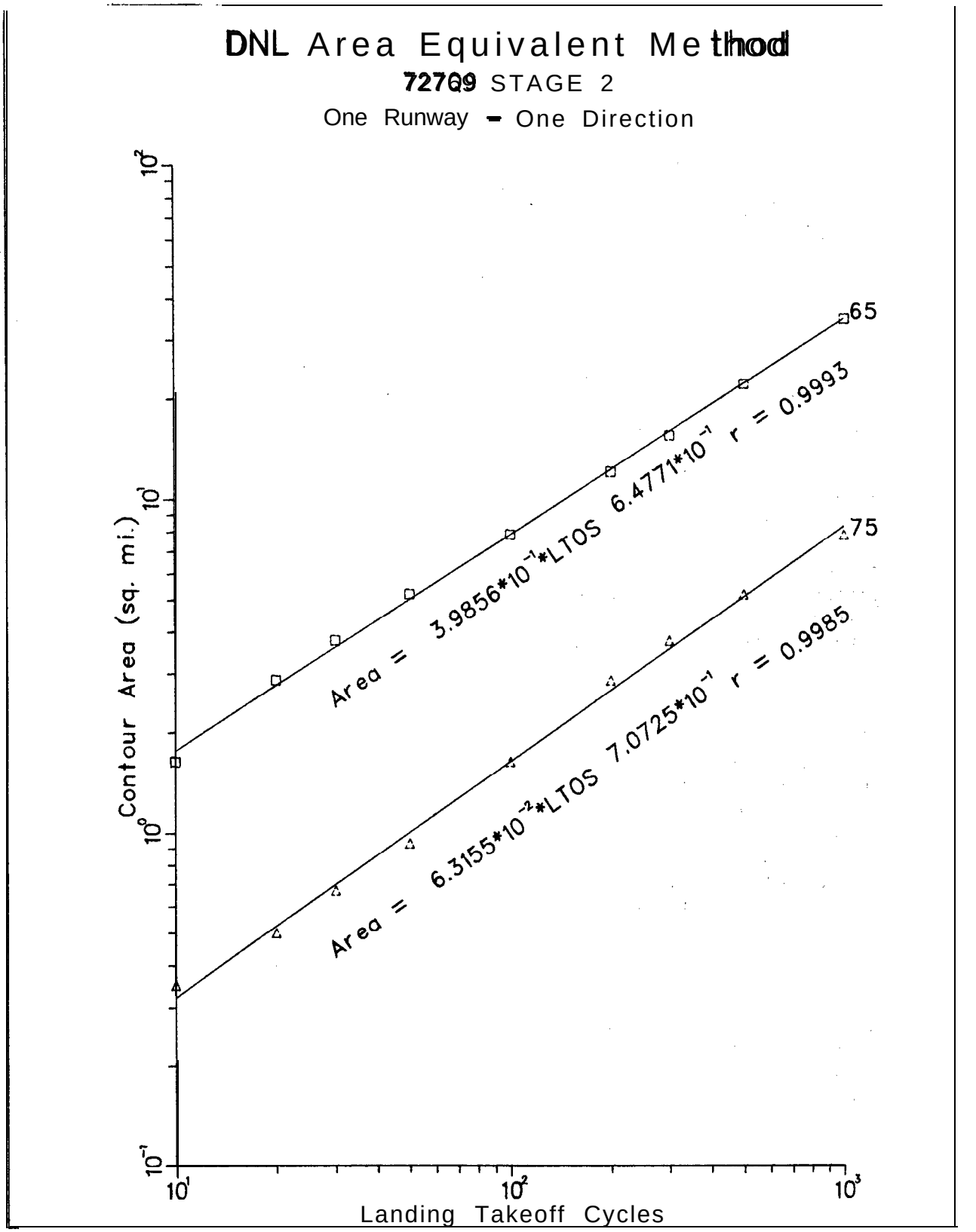


FIGURE 3-1. EXAMPLE OF AEM LINEAR REGRESSION EQUATIONS

TABLE 3-1

AEM PARAMETERS AND CORRELATION COEFFICIENTS

(Part 1 of 2)

AIRCRAFT TYPE	65 LDN a	65 LDN b	65 LDN r	75 LDN a	75 LDN b	75 LDN r
747100	.22594	.70658	.9999	.058717	.65788	.9982
747200	.094848	.71062	.9993	.056022	.52171	.9811
747100	.085753	.70686	.9994	.039767	.56111	.9922
747SP	.072382	.70726	.9987	.031276	.57653	.9989
DC820	.54677	.61749	.9995	.094781	.67403	.9994
707	.43092	.63363	.9997	.081682	.6892	.9999
720	.30018	.65145	.9997	.062408	.66438	.9997
707320	.46628	.63776	.9996	.086793	.67387	.9993
707120	.39068	.63666	.9994	.075951	.66588	.9976
7208	.33421	.64428	.9994	.057873	.68983	.9993
DC850	.45335	.6216	.9994	.085881	.66095	.9988
DC860	.50433	.63693	.9997	.093926	.67211	.9992
DC8CFM	.095168	.56752	.9995	.058978	.42531	.9901
707CFM	.090267	.56054	.9976	.075816	.36805	.9844
707QN	.39478	.61722	.9995	.070882	.66658	.9988
DC8QN	.46346	.60835	.9991	.074511	.68043	.9983
CONCRD	3.1758	.80275	.9987	.21072	.96202	.984
DC1010	.055833	.74586	.9981	.057591	.44377	.969
DC1030	.072532	.7207	.9992	.055537	.48144	.9765
DC1040	.069732	.72171	.9991	.055983	.47362	.9736
L1011	.061686	.74073	.9984	.059958	.45116	.9729
L10115	.070318	.73216	.9987	.061885	.46334	.9727
727200	.37045	.66575	.9994	.063094	.70508	.9984
727100	.31686	.66503	.999	.050802	.71719	.9988
727D15	.68539	.59821	.9996	.102036	.6865	.9976
727Q9	.39856	.64771	.9993	.063155	.70725	.9985
727Q7	.25431	.67698	.9987	.041575	.72221	.9987
727Q15	.63749	.59125	.9996	.088996	.69357	.9974
727D17	.77352	.58384	.9992	.13183	.65354	.9965
A300	.056243	.70843	.9973	.065947	.40001	.9676
767	.045582	.73509	.9994	.029423	.51749	.9843
A310	.049037	.70737	.9975	.033022	.4913	.9897
BAC1111	.45806	.6387	.9998	.045305	.61061	.9996

TABLE 3-1

AEWM PARAMETERS AND CORRELATION COEFFICIENTS

(Part 2 of 2)

AIRCRAFT TYPE	65 LDN a	65 LDN b	65 LDN r	75 LDN a	75 LDN b	75 LDN r
F28	a114424	.67717	.9979	.061902	a51202	.9969
DC930	.255	.64224	19992	.0470222	.67878	.9992
DC910	a15256	.68445	.9994	.028217	.70457	.9974
737	a20892	.67236	.9977	.032167	172995	a9991
DC909	.197709	a65771	.9971	.034592	.70398	.9957
DC907	a12141	169248	.9992	.023937	869715	.9941
737QN	.177448	.68081	a9973	a02582	87414	.9974
DC950	a54058	058632	a9992	a084585	.6713	.9977
737D17	147652	a58646	.999	a058649	.71554	.9983
DC980	.0572292	.7005	.9989	n029371	.53347	.985
757RB	.035748	.78426	.9998	.028126	.51577	.9737
757JT	.035748	178426	.9998	a028126	.51577	.9737
COMJET	a28504	.61027	.9993	.058735	.64206	.9995
GALTF	.044167	.62141	.9993	S030673	.4399	a9814
GALTJ	a38843	a60457	.9996	a061997	a68055	.999
GAMTF	a052119	.63153	.9971	.037255	.43601	.9889
GALBTF	.022013	.52699	a9789	.015311	a3752	a9882
L188	n016869	.78133	.9863	.029594	a37025	a9639
L100	.033394	.79478	a9983	S026474	A51004	.9815
DHC7	.011101	.68707	.9794	80073122	.47978	.9967
CV580	0020242	.632	.9712	a025308	.33308	.9961
HTETP	.026254	.69683	.9935	.030705	.39219	.9764
MTETP	.023894	.51311	.9644	.020488	.33031	.9881
DHC6	.015311	a4805	.9796	.0042779	.51577	.9779
4EP	a058605	.81526	19993	.033666	158784	19876
TEP	.042943	a75885	.9989	.034507	.49549	.9898
COMTEP	.016671	a49302	.9749	.004013	.54427	.9773
COMSEP	a0096306	.54076	.9782	a0026634	.54335	.9829
KC135	2.78893	.63015	.9988	.45159	a69334	.9995
C130	n033394	179478	.9983	.028474	.51704	.9815
F4	1.03001	.66118	.9999	.23697	165296	.9994
A7D	.47499	a6484	19996	.115567	.63347	.9996
CL600	.049046	.5045	a9848	S039268	.33787	.9976

4.0 LOTUS 1-2-3 METHOD

The AEM doesn't require any programming experience. It does require LOTUS 1-2-3™ and an IBM® Personal Computer, an IBM/XT™, or the COMPAQ™ portable computer. LOTUS 1-2-3 is an electronic worksheet which is combined with graphics and data base management. In LOTUS 1-2-3 parlance, AEM is a template called DNLAEM (Figure 4-1) which is stored on a 5-1/4 inch diskette. Appendix A provides instructions on how to obtain a copy of DNLAEM. When retrieved from the diskette the DNLAEM template becomes a worksheet to which you add aircraft identities and the associated landings and takeoffs (LTOs) in the appropriate columns (see Figure 4-2).

DNLAEM contains all the equations necessary to calculate an airport contour area from the list of aircraft types and LTOs. DNLAEM includes the a and b parameters for each of the 66 aircraft shown in Table 3-1. The following instructions should lead you to produce output reports similar to those. examples in Figures 4-3 and 4-4. The keystrokes are given in **boldface type.** **ENTER** indicates the key labeled ↵ . An item enclosed in **[ ]** indicates one of the special function keys located on the left of the IBM keyboard.

4.1 INSTRUCTIONS

Once you have LOTUS 1-2-3 booted with a blank template on the screen follow these procedures to run the AEM.

Instruction	Comment
STEP 1. Insert AEM Disk into Drive A.	
STEP 2. **/FD**	**/** shifts you into command menu. F selects File. **D** indicates desire to change drive and directory.
STEP 3. **A:** and **ENTER**	Changes drive and directory.
STEP 4. **/FR**	**/** shifts you into the command menu. F selects File. **R** indicates the desire to retrieve a template.
STEP 5. Hit → until **'DNLAEM'** is highlighted.	
STEP 6. Hit **ENTER** .	The AEM template is being loaded.

DNLAEM

Day Night Average Sound Level
Area Equivalent **Method**

_____ **(((Title** (Hit " to start)
_____ **(((Level (1=65** or **2=75 Ldn)**

NA **Ldn**

Aircraft	**LTO Cycles**			Constants		**Aircraft**			To **Verify** Area	
ID	**Day**	Night	Weighted	a	b	Area	Energy	**Vgtings**	**LTOs**	**Eff LTOs**
			0	**NA**	**NA**	0	0	0	0	0
			0	**NA**	**NA**	**0**	0	**0**	b	0
			0	**NA**	**NA**	b	b	0	b	0
			0	HA	**NA**	0	b	**0**	0	0
			b	**NA**	**NA**	0	b	0	b	0
			b	**NA**	**NA**	0	b	0	0	**0**
			0	**NA**	**NA**	b	0	0	0	0
			b	**NA**	HA	b	**0**	0	0	**0**
			b	**NA**	**NA**	b	0	0	0	0
			b	**NA**	**NA**	b	b	0	b	**0**
			b	**NA**	HA	0	b	0	0	0
			b	HA	**NA**	b	b	**0**	b	**0**
			0	**NA**	**NA**	b	b	0	0	0
			b	**NA**	**NA**	b	b	0	b	0
			b	**NA**	**NA**	0	0	0	0	**0**
			b	**NA**	**NA**	b	0	0	**0**	**0**
			b	**NA**	**NA**	0	b	0	b	**0**
			0	**NA**	**NA**	b	b	**0**	0	**0**
			0	**NA**	**NA**	b	b	0	b	0
			0	**NA**	**NA**	0	0	b	b	**0**
						0	0	0		0
Totals:	. **0**	0	0			0	**(Ref** Area	Validity Test **(1=TRUE,0=FALSE)**		0

Contour Area = **NA sq. mi.**

FIGURE 4-1. DNLAEM, THE AEM LOTUS 1-2-3 TEMPLATE

DNLAEM

Day Night, Average Sound Level
Area Equivalent Method

_____ (<<Title (Hit " to start)
_____ <<<<Level (1=65 or 2=75 Ldn))

Aircraft ID	LTO Cycles Day	Night
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
Totals:	0	0

Aircraft Type	Aircraft ID	Aircraft Type	Aircraft ID
7471000	1	F28	34
7472000	2	DC930	35
7471000	3	DC910	36
747SP	4	737	37
DC820	5	DC9Q9	38
707	6	DC9Q7	39
720	7	737QN	40
7073200	e	DC950	41
7071200	9	737D177	42
720B	to	DC980	43
DC850	11	757RB	44
DC860	12	757UT	45
DC8CFM	13	COMJET	46
707CFM	14	GALTF	47
707QN	15	GALTJ	48
DCBQN	16	GAMTF	49
CONCRD	17	GALQTF	50
DC1010	18	L188	51
DC1030	19	L1000	52
DC1040	20	DCH7	53
L1011	21	CV580	54
L101155	22	HTETP	55
7272000	23	MTETP	56
7271000	24	DCH6	57
727D155	25	4EP	58
727Q9	26	TEP	59
727Q7	27	COMTEP	60
727Q155	28	COMSEP	61
727D177	29	KD135	62
A300	30	C130	63
767	31	F4	64
A310	32	A7D	65
BAC111	33	CL600	66

FIGURE 4-2. DNLAEM FILLIN FORMAT

DNLAEM

Day Night Average Sound Level
Area Equivalent Method

LONG BCH (((Title (Hit " to start)
1 (((Level (1=65 or 2=75 Ldn)

65 Ldn

Aircraft ID	LTO Cycles Day	Night	Weighted	Constants a	b	Aircraft Area	Energy	Weightings	To Verify Area LTOs	Eff LTOs
26	3		3	0.39856	0.64771	0.811951	0.575040	0.167804	9.076822	0.330512
43	14		14	0.057292	0.7005	0.363878	0.190634	0.272140	122.54998	0.114239
46	16		10	0.265044	0.61027	1.161918	1	1.638618	17.999773	0.555563
			0	NA	NA	0	0	0	0	0
			0	HA	NA	0	0	0	0	0
			0	NA	HA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
			0	NA	NA	0	0	0	0	0
Totals:	27	0	27			1.161918	1.765674	2.790564		1.000315
						1.161918	(Ref Area Validity Test (1=TRUE,0=FALSE)			1

Contour Area = 1.66 sq. mi.

FIGURE 4-3. EXAMPLE OF AEM 65 L_{dn} OUTPUT FROM LOTUS 1-2-3

DNUAEM

Day Night Average Sound Level
Area Equivalent Method

LONG RCH ((<Title (Hit " to start)
2 (((Level (1=65 or 2=75 Ldn)

75 Ldn

Aircraft ID	LTO Cycles Day	Night	Weighted	Constants a	b	Aircraft Area	Energy	Weightings	To Verify Area LTOs	Eff LTOs
26	3	[illegible]	3	0.0631555	0.707225	0.1373357	0.4111066	0.5811133	11.466647	0.2616832
43	14	[illegible]	14	0.0298371	0.533347	0.1210044	0.2318922	0.4472966	106.61066	0.1313188
46	LO	[illegible]	10	0.0587335	0.642066	0.2576066	1	1.5574866	16.446652	0.6000031
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	WA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	0	NA	NA	0	0	0	0	0
[illegible]	[illegible]	[illegible]	.0	NA	NA	0	0	0	0	0
						0.2576066	1.649999	2.5186616		1.0000982
Totals:	27	0	27			0.2576066	(Ref Area	Validity Test (1=TRUE,0=FALSE)		1

Contour Area = 0.35 sq. mi..

FIGURE 4-4. EXAMPLE OF AEM 75 Ldn OUTPUT FROM LOTUS 1-2-3

Instruction	Comment
STEP 7. Wait for the cursor to appear in coordinate H5. If you are not in H5 type [F5]H6 and ENTER .	[F5]1, invokes the GOTO command and H5 indicates the destination coordinate.,
STEP 8. Hit " (quote mark), enter title (up to. 9 characters) and hit ENTER .	The " causes LOTUS 1-2-3 to treat the entry as a label.
STEP 9. Hit ↓ .	The cursor moves to H6.
STEP 10. Enter 1 or 2 and ENTER .	You are choosing between calculating 65 L_{dn} (1) or 75 L_{dn} (2) Contour area.
STEP 11. Type [F5]H1 1 and ENTER .	The cursor moves to the first coordinate under the column labeled 'Aircraft ID'.'
STEP 12. For each aircraft type enter corresponding ID and hit ↓ .	The cursor moves down the column as you enter each aircraft. Up to 20 allowed.
STEP 13. Type [F5]I 11 and ENTER .	The cursor moves to the first coordinate under the column labeled 'DAY'.
STEP 14. For each aircraft type enter the corresponding LTOs during daytime and hit ↓ .	Daytime includes the hours 7am to 10pm; The cursor moves down the column after each entry.
STEP 15. Type [F5]J1 1 and ENTER .	The cursor moves to the first coordinate under the column labeled 'NIGHT'.
STEP 16. For each aircraft type enter the LTOs which occur at night and hit ↓ .	Night includes the hours 10pm to 7am. The cursor moves down the column after each entry.
STEP 17. Type [F9] .	The cursor disappears and the computations have begun. Return of cursor signals end of calculations.,

Instruction	Comment
STEP 18. Type **[F5]K31** and **ENTER**.	
STEP 19. If coordinate P35 contains 'NA' then type **[F5]H5** and **ENTER**. Go back to STEP 7 and check your entries.	Something is wrong with your input.
STEP 20. If coordinate R32 contains '1' then skip to STEP 29.	Your results are correct. You may now print them out.
STEP 21. Write down value in R31.	Validity test is FALSE.
STEP 22. Type **[F5]N32** and **ENTER**.	N32 contains reference area.
STEP 23. Enter a new reference contour area.	If value in R31 is greater than 1.02 then enter a number less than shown. Otherwise, enter a number greater than shown.
STEP 24. Hit **ENTER** then **[F9]**	Recalculation starts. Await return of cursor.
STEP 25. Type **[F5]K31** and **ENTER**.	
STEP 26. If R32 contains '0' then repeat steps 21 through 25 until R32 contains '1'.	
STEP 27. Type **[F5]N32** and **ENTER**.	Validity test is now TRUE.
STEP 28. Type **+N31** and **ENTER**	The coordinate N32 is now returned to its original value.
STEP 29. Write down contour area.	If you don't have a printer, you are done.
STEP 30. Type **[F5]H1** and **ENTER**.	
STEP 31. Make sure printer is turned on and ready.	
STEP 32. Type **/PPR H1.R35** and **ENTER**.	**/** shifts into command menu. **P** is PRINT command. **P** indicates that output goes to PRINTER. **R** indicates you want to enter the RANGE of cells to be printed. **H1.R35** are cells to be printed. Cursor returns to PRINTER menu. If you are printing on 14"x11" paper, skip to step 35.

Instruction	Comment
STEP 33. Type OS and	O shifts into OPTIONS menu. S indicates you would like to enter special printer SETUP commands.
\030, or	For 12 CPI.
\031, or	For 16.8 CPI.
\029 and ENTER .	To return to default of 10 CPI. These commands work only with certain kinds to printers. Cursor returnsto OPTIONS menu.
STEP 34. Type Q .	Q is QUIT OPTIONS menu and return to PRINTER menu.
STEP 35. Type G .	G is GO command. Worksheet is being printed. Cursor returns to PRINTER menu.
STEP 36. Type Q .	Q allows you to leave the PRINTER menu.

The real utility of LOTUS 1-2-3 comes from the fact that the worksheet is still available for you to change any of your entries and rerun. For example, let's say that you have just produced the 65 Ldn contour area and you want to calculate the area within 75 Ldn. Simply go to coordinate H6 and enter a 2 and ENTER. Skip to STEP 17 and proceed.' You can do the same thing with aircraft types or LTOs. You can even save just the worksheet portion and then reload it onto a blank AEM template later. To save, you would use /FX which creates a file (you supply a filename) that stores all data currently located in the indicated cell range. To reload the file you would use /FC which would overlay the stored worksheet portion over the current AEM template at the specified location. You could then make necessary changes to that data and proceed again from STEP 17.

5.0 CALCULATOR METHOD

In the event that an IBM computer and LOTUS 1-2-3 software are not available, your calculator and the worksheet in Figure 5-1 make good substitutes. With the following instructions, you perform the same tasks as accomplished by the AEM on LOTUS 1-2-3.

5.1 INSTRUCTIONS

STEP 1. Enter aircraft types in column 1.

STEP 2. Enter the daytime and nighttime LTOs for each aircraft. type in columns 2 and 3, respectively.

STEP 3. Compute the effective LTOs of each aircraft in column 4 by multiplying the nighttime LTOs from column 3 by 10 and adding the daytime LTOs from column 2.

STEP 4. Enter in columns 5 and 6 the- appropriate aircraft a and b parameters for either 65 or 75 L_{dn} from Table 3-1.

STEP 5. Compute the area of each aircraft by applying the equation in the development section $A=aN^b$ where a is in column 5, b is *in column 6, and N is the number of effective LTOs in column 4. Enter the. area A, for each aircraft. in column 7."

STEP 6. Select the largest area in column 7 and refer to this as the "reference area," AR.

STEP 7. Calculate the' energy contribution E for each aircraft. This is done by dividing the area of each aircraft by the reference area and raising the quotient to the power. of the reciprocal of the b parameter (l/b). Enter the result in column 8.

STEP 8. Sum column 8 and enter the result in the box labeled $\overline{E}$.

STEP 9. Calculate the weighting factor W for each aircraft with the equation $W=E/b$. Divide the energy contribution E of each aircraft by the b parameter and enter the quotient in column 9.

STEP 10. Sum column 9 and enter the result in the box labeled $\overline{W}$.

STEP 11. Calculate-the scaling parameter 6 for the aircraft mix by dividing E by $\overline{W}$. Enter the quotient in the box labeled $\overline{b}$.

STEP 12. Calculate the contour area of the aircraft mix by applying the energy contribution E, the scaling parameter $\overline{b}$, and the reference area AR to the equation $\overline{A}=AR(\overline{E}^{\overline{b}})$. The result $\overline{A}$ is the DNL noise contour area of the specific aircraft mix.

STEP 13. Determine the number of LTOs that each aircraft must fly in order to have a noise contour area equal to that of the entire mix. This is done by dividing the DNL noise 'contour area of the entire mix $\overline{A}$ by the parameter a in column 5 and raising the quotient to the power of the reciprocal of the b parameter in column 6. Enter the result $\overline{N}$ in column 10.

STEP 14. Calculate the ratio of LTOs of-each aircraft by dividing the effective LTOs in column 4 by N in column 10. Enter the result in column 11.

STEP 15. Sum column 11 and enter the result in the box labeled 'Validity Check'.

STEP 16. If the validity value is between 1.00 and 1.02 then the result is correct. You are done. Record the contour area from the box labeled "A:" into the box labeled "Contour Area:".

STEP 17. If the validity value is not between 1.00 and 1.02, return to STEP 1 and check all your figures.

STEP 18. If the validity check produces the same value, change the reference area according to the following:

(a) If the validity value is greater than 1.02, enter a reference area less than already present.

(b) If the validity value is less than 1.00, enter a reference area greater than already present.

STEP 19. Repeat the steps starting at STEP 7.

APPENDIX A

AVAILABILITY OF AEM ON LOTUS 1-2-3

The AEM is available on a double-sided, double-density 5-1/4 inch diskette. The information on the diskette is compatible with LOTUS 1-2-3™ for IBM@ personal computer, IBM/XT™, and COMPAQ™ portable computer. The cost to you is $10 for materials and services. To order AEM on LOTUS 1-2-3, fill out request form (p. A-2) and send with check or money order payable to the "United States Treasury" to:

Federal Aviation Administration
AEE-120
800 Independence Ave., S.W.
Washington, DC 20591
Attention: Donna G. Warren

Appendix B contains a listing of the AEM template for LOTUS 1-2-3.

AEM ON LOTUS 1-2-3 REQUEST

I request a 5-1/4 inch diskette of the AEM.

NAME: _____

TITLE: _____

COMPANY: _____

STREET ADDRESS: _____

CITY, STATE ZIP: _____

TELEPHONE NO.: _____

APPENDIX B

ABM TEMPLATE LISTING

This appendix contains the keystrokes to create the DNLAEM template on LOTUS 1-2-3. Please refer to the LOTUS 1-2-3 user manual for an explanation of the commands. Entry at a particular coordinate (or cell) is shown as the coordinate identification followed by a colon and then the appropriate keystrokes. Keystrokes which are shown without a coordinate identification always refer to the previously specified coordinate, usually on the line above. Table B-l contains the locations (row and column) of the specific aircraft a and b parameters on the ABM template. Table B-2 provides the locations of the aircraft names and identifications.

```
Al  : [illegible]
      /RNC\0
      Al
      /WCFG/WGRM
A8  : (SH$6-1)*2+1
All: +Hll
      IC
      A12.A30
B10: "a
B11: @IF(All=0,8NA,@VLOOKUP(All,SB$47.SF$112,~A$8~~)
      IC
      B12.B30
C10: "b
C11: @IF(All=0,8NA,@VLOOKUP(All,SB$47.SF$112,~(A$8+1~~)
      IC
      C12.C30
H2  : "Day Night
H3  : "    Area E
H5  : "___________ (9 underline strokes)
H6  : "___________
H9  : "Aircraft
H10: AID
H11: "88_________! (7 underline strokes between two exclamation points)
      IC
      H12.H30
      /C
      Hll.H30
      Ill.J30
H32: "Totals:
I1  : "DNLAEM
I2  : "Average
I3  : "quivalent
I5  : "<<<Title
I6  : "<<<Level
I9  : "          L
I10: "Day
I32: @SUM(Ill.f30)
      IC
      532.K32
```

```
J2ZY  "Sound Lev
J3  :  'Method
J5  :  '(Hit '' to
J6  :  '(11=65 or
J9  :  'TO Cycles
J10::  '  Night
K2  :  'cl
KS  :  'start)
K6  :  ' 2=75 Ldn)
K10::  ' Weighted
K11::  +I11+((J11*10))
       /C
       K12..K30
L9  :  '        Cons
L10::  Aa
L11::  @IF(@ISNA(B11),@NA,B11)
       /C
       L12..L30
M7  :  @IF(H6<1#OR#H6>2,@NA,@CHOOSE(H6-1,65,75))
M9  :  'tants
M10::  Ab
M11::  @IF(@ISNA(C11),@NA,C11)
       /C
       M12..M30
N7  :  "Ldn
N9  :  "Aircraft
N10::  *Area
N11::  @IF(@ISNA(L11),0,+L11*(K11*M11))
       /C
       N12..N30
N31::  @MAX(N11..N30)
N32::  +N31
N35:   "     Contou
O10::  "Energy
O11::  @IF(~$N$32=0#OR#@ISNA(M11),0,(N11/$N$32)*(1/M11))
       /C
       O12..O30
O31::  @SUM(O11..O30)
O32:   '(Ref Area
O35:   "r Area =
P10::  "Wgttimgs
P11::  @IF(@ISNA(M11),0,O11/M11)
       /C
       P12..P30
P31::  @SUM(P11..P30)
P32::  "       Valid
P33::  '       (1=TR
P35::  /RFF2P35
       @IF(P31=0,@NA,+(O31*O31/P31)*N31)
```

```
Q9  : "  To Veri
Q10 : "LTOs
Q11 : @IF(~(@ISNA(L11)#OR#@ISNA(M11)),0,(~$P$35/L11)*(/M11))
      /C
      Q12.Q30
Q32 : 'itty Test
Q33 : 'UE,0=FALS
Q35 : " sq. mi.
R9  : 'fy Area
R10 : 'Eff LTOs
R11 : @IF(Q11=0,0,+K11/Q11)
      /C
      R12.R30
R31 : @SUM(R11.R30)
R32 : @IF((R31)>=1/#AND#R31<=102)@TRUE,@FALSE)
R33 : 'E)
```

TABLE B-l

LOCATIONS OF A AND B PARAMETER ON AEM TEMPLATE

		COLUMN A	B	C	D	E	F
	44	AIRCRAFT TYPE	AIRCRAFT ID	65 LDN A	65 LDN B	75 LDN A	75 LDN B
	45						
	46						
	47	747100	1	0.225394	0.706658	0.058717	0.65688
	48	747200	2	0.094848	0.711062	0.056022	0.521711
	49	747100	3	0.085753	0.706866	0.039767	0.561111
	50	747SP	4	0.072382	0.707256	0.031276	0.576653
	51	DC820	5	0.546777	0.617409	0.094781	0.576653
	52	707	6	0.430922	0.633363	0.081632	0.674003
	53	720	7	0.300188	0.651145	0.062408	0.6692
	54	707320	8	0.466228	0.637776	0.086793	0.66438
	55	707120	9	0.390668	0.636666	0.075951	0.673307
	56	7208	10	0.334221	0.644238	0.057873	0.68983
	57	DC850	11	0.453335	0.62156	0.065881	0.66095
	58	DC860	12	0.504333	0.636693	0.093256	0.672111
	59	DC8CFM	13	0.095168	0.566752	0.058978	0.425531
	60	707CFM	14	0.090267	0.560534	0.075846	0.368065
R	61	707QN	15	0.394738	0.617222	0.070802	0.66658
O	62	DC8QN	16	0.463466	0.608835	0.074511	0.660443
W	63	CONCRD	17	3.17538	0.802775	0.210722	0.962202
	64	DC10100	18	0.055833	0.746366	0.057591	0.443777
	65	DC10300	19	0.072532	0.72207	0.055537	0.481444
	66	DC10400	20	0.069732	0.721771	0.055983	0.473362
	67	L1011	21	0.061686	0.740773	0.059958	0.451116
	68	L1Q115	22	0.070318	0.732156	0.061885	0.463334
	69	727200	23	0.370465	0.665775	0.063094	0.705308
	70	727100	24	0.316686	0.665503	0.050802	0.717119
	71	727D155	25	0.685339	0.591255	0.102036	0.69865
	72	727109	26	0.398856	0.647711	0.063155	0.707225
	73	727107	27	0.254831	0.67698	0.041575	0.722221
	74	727015	28	0.637409	0.591125	0.088986	0.693357
	75	727017	29	01.77352	0.588884	0.131883	0.653354
	76	A300	30	0.056248	0.708843	0.065947	0.400001
	77	767	31	0.045382	01.735009	0.029423	0.517409
	78	A310	32	0.049037	0.707237	0.033022	01.4913

		COLUMN A	B	C	D	E	F
	79	BAC1111	33	0.158006	0.6387	0.045305	0.600611
	80	F28	34	0.114424	0.677177	0.061902	0.612202
	81	DC930	35	0.255	0.642224	0.047022	0.678788
	82	DC910	36	0.152556	0.684445	0.028217	0.704457
	83	737	37	0.208892	0.672336	0.032167	0.722985
	84	DC909	38	0.197709	0.657771	0.034592	0.703988
	85	DC907	39	0.121141	0.692488	0.023937	0.697715
	86	737QN	40	0.174488	0.680881	0.02382	0.74414
	87	DC950	41	0.540558	0.586632	0.084385	0.67183
	88	737D17	42	0.476652	0.586466	0.058409	0.71554
	89	DC980	43	0.057292	0.7005	0.029371	0.533347
	90	757RB	44	0.035748	0.784256	0.028256	0.515577
	91	757JT	45	0.035748	0.78426	0.028256	0.515577
	92	COMQET	46	0.265504	0.610227	0.058735	0.64206
	93	GALTF	47	0.044167	0.621141	0.030673	0.43989
	94	GALTU	48	0.388483	0.604457	0.061997	0.680555
	95	GAMTF	49	0.052119	0.631583	0.037255	0.436001
R	96	GALQTF	50	0.022013	0.52699	0.015311	0.37552
O	97	L188	51	0.016659	0.781333	0.029594	0.370255
W	98	L1000	52	0.033394	0.794728	0.026474	0.517004
	99	DCH7	53	0.011101	0.687707	0.007312	0.479788
	100	CV580	54	0.020242	0.632	0.025308	0.333008
	101	NTETP	55	0.026254	0.696683	0.030705	0.392199
	102	MTETP	56	0.023894	0.513111	0.020488	0.330331
	103	DCH6	57	0.015311	0.4805	0.004277	0.515577
	104	4EP	58	0.058605	0.815256	0.033666	0.587884
	105	TEP	59	0.042943	0.758885	0.034507	0.495409
	106	COMTEP	60	0.016671	0.493302	0.004013	01.54427
	107	COMSEP	61	0.009630	0.540776	0.002663	0.548335
	108	KD135	62	2.78983	0.630155	0.451559	0.69334
	109	C130	63	0.033394	0.794728	0.026474	0.517004
	110	F4	64	1.03001	0.661118	0.236697	0.65296
	111	A7D	65	0.47499	0.64664	0.115567	0.633347
	112	CL600	66	0.049046	0.5045	0.039268	0.337787

TABLE B-2

LOCATIONS OF AIRCRAFT NAMES AND IDENTITIES ON AEM TEMPLATE

		COLUMN S	T	U	V
	9	Aircraft	Aircraft	Aircraft	Aircraft
	10	Type	ID	Type	ID
	11	747100	1	F28	34
	12	747200	2	DC930	35
	13	747100	3	DC910	36
	14	747SP	4	737	37
	15	DC820	5	DC9Q9	38
	16	707	6	DC9Q7	39
	17	720	7	737QN	40
	18	707320	8	DC950	41
	19	707120	9	737B17	42
	20	720B	10	DC980	43
	21	DC850	11	757RB	44
	22	DC860	12	757JT	45
	23	DCBCFM	13	COMJET	46
	24	707CFM	14	GALTF	47
R	25	707QN	15	GALTJ	48
0	26	DC8QN	16	GAMTF	49
W	27	CONCRD	17	GALQTF	50
	28	DC10 10	18	L188	51
	29	DC10 30	19	L100	52
	30	DC10 40	20	DCH7	53
	31	L1011	21	CV580	54
	32	L101 15	22	HTETP	55
	33	727200	23	MTETP	56
	34	727100	24	DCH6	57
	35	727D15	25	4EP	58
	36	727Q9	26	TEP	59
	37	727Q7	27	COMTEP	60
	38	727Q15	28	COMSEP	61
	39	727D17	29	KD135	62
	40	A300	30	C130	63
	41	767	31	F4	64
	42	A310	32	A7D	65
	43	BAC111	33	CL600	66

APPENDIX C

REFERENCES

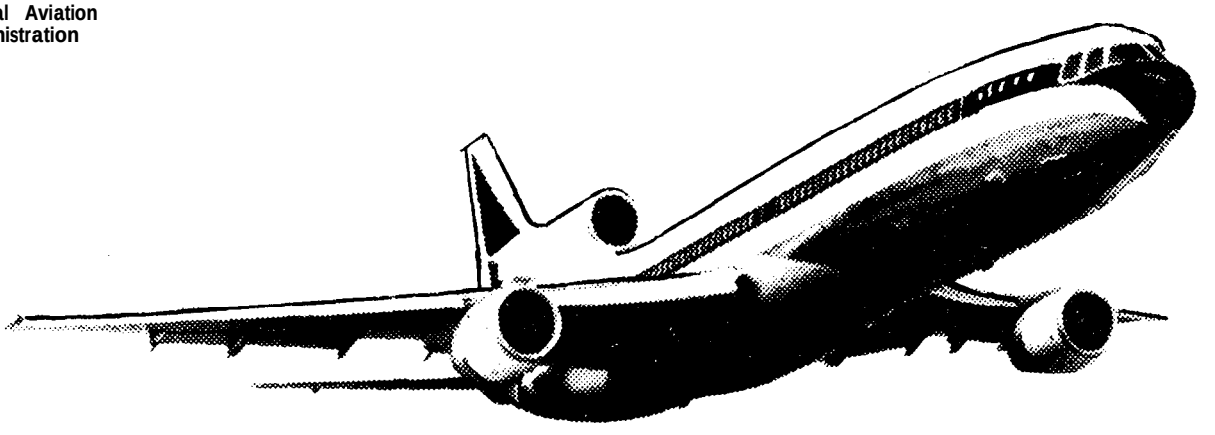
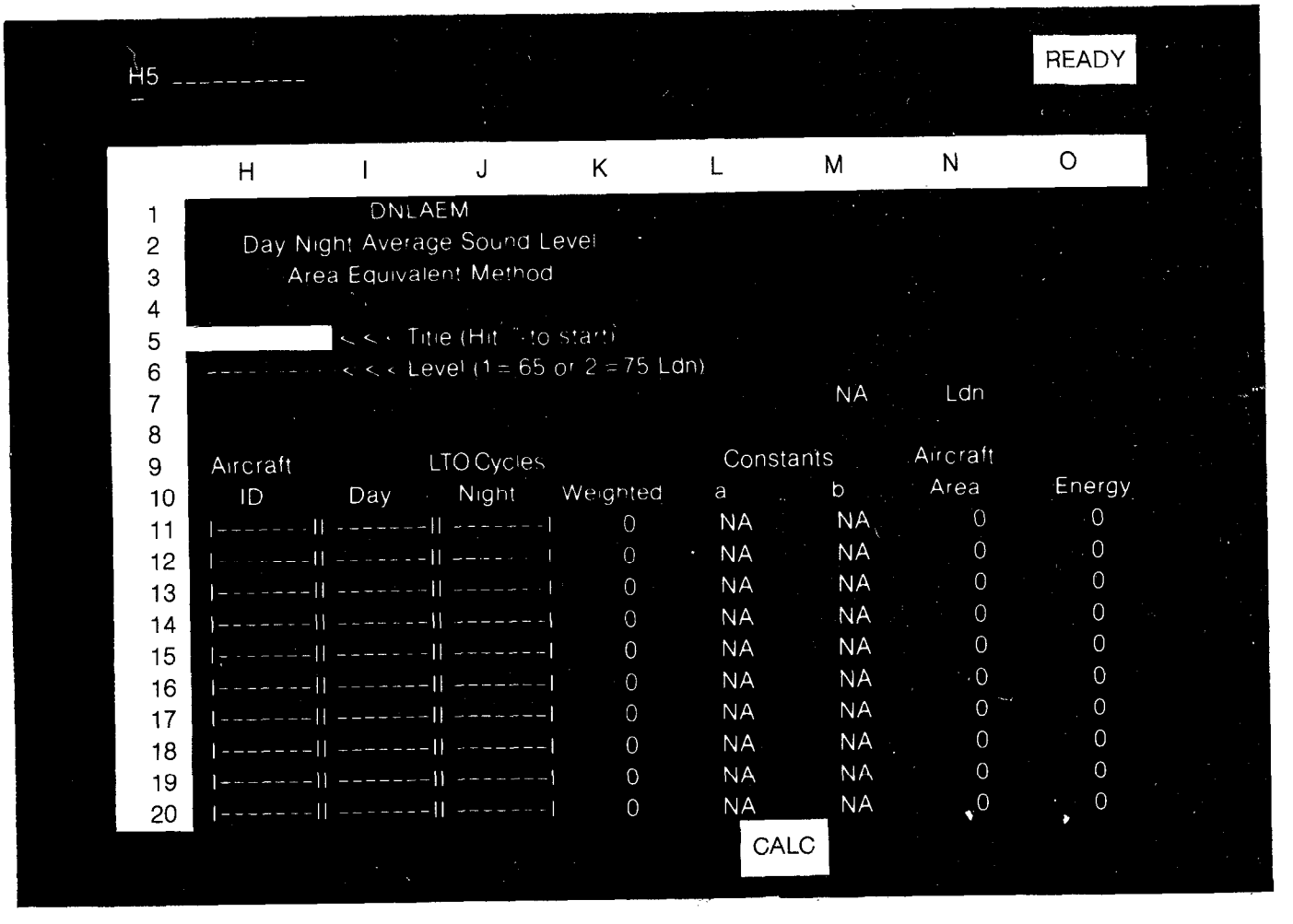
1. Civil Aeronautics Board, "Area Equivalent Method," February 1982.

2. Flythe, M. C., "INM Integrated Noise Model, Version 3 User's Guide," FAA-EE-81-17, October 1982.

3. Connor, T. L. and Fortescue, D.N., "Area Equivalent Method on VISICALC?, FAA-EE-84-8, February 1984.

AREA EQUIVALENT METHOD on LOTUS 1-2-3™

By: Donna G. Warren

July 1984
Report No. EE-84-12

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