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（出國類別： 進 修 ）

美國航空總署噪音模式訓練
出國報告書

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內容摘要: 學習美國航空總署所研發之INM6.0版操作技術，及航空噪音監測技術、自動連續監測設施設置方式、航空噪音監測資料判讀技巧，建置我國航空噪音監測設施、資料收集、資料判讀分析方法及航空噪音防制區劃定技術、健全航空噪音防制區化作業及劃定技術健置，落實航空噪音監測資料評估分析能力

本文電子檔已上傳至出國報告資訊網

壹、國內航空噪音管制現況：

民國八十一年有鑒於航空噪音陳情案件日益增加，民眾抗爭愈演愈盛，且「噪音管制法」及「民用航空法」中並無相關規定，故為解決航空噪音干擾環境安寧問題，並杜息民怨，環保署即邀請交通部、國防部及內政部營建署共同訂定「機場周圍地區航空噪音防制辦法」，於八十三年八月三十一日由本署發布實施。並陸續訂定發布「民用航空器噪音管制辦法」、「軍事機關及其所屬單位之場所設施工程及機動車輛航空器等裝備噪音管制辦法」及「機場周圍地區航空噪音防制辦法」，據以推動機場周圍地區噪音防制工作。

依據「噪音管制法」第十一條規定，於八十一年及八十四年陸續指定公告台北松山、桃園中正、台中水湳、台南、高雄小港、花蓮、桃園軍用、新竹、台中清泉崗、高雄岡山、台東志航、台東豐年、屏東、嘉義、金門尚義、澎湖馬公等十六處機場為應設置航空噪音自動監測設備之航空站，並要求各機場航空主管機關於設置滿一年起按季申報實際監測紀錄、飛航動態紀錄及等噪音線圖。各機場所在地方環保主管機關已陸續依各機場所申報之等噪音線圖、實際監測紀錄、附近地形及土地使用情形，辦理劃定各級航空噪音管制區公告實施，據以向航空主管機關申請補助防音設施。另依「機場周圍地區

航空噪音防制辦法」規定，航空主管機關為減低機場航空噪音影響，對於經公告指定之航空站應採取下列防制措施：

1. 依機場用途、航空器型式，調整航空器起降時間。
2. 在不影響飛航安全下，調整操作程序、限制試車或訓練飛行時間。
3. 對機場及其周圍應設置緩衝綠帶或隔音牆，並對其設備應加裝消音裝置等防音設施。
4. 補助機場周圍地區受航空噪音影響之學校、圖書館及住戶設置防音設施。

貳、航空噪音特性

一般民航機（噴射客機）主要噪音源有排氣噪音及引擎噪音，排氣噪音屬寬頻帶噪音，噪音量與排氣速度有關；引擎噪音因引擎外殼振動與引擎內部葉片轉動時所引起之擾流噪音，據純音特性，約 2K 至 4KHz 之間。

航空噪音的種類依航空器操作狀態及機場內高噪音設施種類及作業，可分為航空器起飛、降落、滑行、試車、待命等待噪音，機場作業環境地面動力裝備(GPU)、輔助動力裝備(APU)、氣源車、電源車等設施噪音。機場內每一種噪音源因型式種類、操作狀態其噪音量、頻率特性、及持續時間有很大的差異。

航空噪音最大噪音量(Lmax)在近跑道處可達130dBA以上，加上滑行、飛行距離長和居高臨下等因素，受其噪音影響的範圍便相當廣。航空噪音大小和飛航軌道距離、飛航程序等有關，航程、載重大小造成使用推力的不同，亦間接影響其噪音值。在飛機起飛階段，由於必須配合使用後燃器的大馬力推進，其噪音量最大，噪音影響範圍會因爬升仰角和起飛後轉彎的距離有顯著的不同。在飛機降落階段，飛機進場多使用部分巡航馬力，雖然噪音量不若起飛時大，但因需對準跑道，且多循三度下滑角降落，因此持續時間較長。在滑行階段，飛機起飛前，由停機坪滑行至跑道端待命，或降落後由跑道滑行至停機坪，雖飛機馬力已很小，但因持續時間長，尤其滑行動線接近機場外圍時。在試車或溫車待飛時，其噪音量視推力大小及持續時間長短而定。

目前，依「機場周圍地區航空噪音防制辦法」規定，目前我國採用航空噪音日夜音量 DNL 做為評估指標，便考慮了持續時間和夜間飛航噪音事件之加權。

航空噪音的種類因航空器起飛、降落、滑行、試車、待命等所產生的噪音，及地面動力裝備、輔助動力裝備等設施所產生的噪音，其噪音特性可由操作狀態區分出不同頻帶的噪音量。

1.起飛及降落噪音：

起飛噪音大而短、.降落噪音大而長、反槳噪音伴隨有低頻的振波，因飛機起飛時需要最大推力，其噪音量是最大的，而其噪音量及持續時間又與航空器型式、起飛仰角大小、轉彎的時機有關，降落噪音雖不比起飛的噪音量大，但因飛機須對準跑道，且循 3 度標準下滑進場，其持續的時間較長；尤其降落時，為產生較佳的煞車作用，往往會使用反槳，其產生的噪音量相當大，如不使用反槳作用，又會使飛機在跑道上滑行的時間加長，此也是起降噪音防制上的一個矛盾。

2.滑行噪音：

滑行噪音有固定行進方向且其持續時間較長，飛機在起飛前滑出機坪至跑道、降落後由跑道回至機坪、由停機坪至試車機坪或棚廠維修時，均會產生滑行噪音，其特點在於推力不大，持續時間長，且有固定的動線。

3.作業環境噪音：

地面輔助動力裝備噪音尖銳變化平穩及持續時間長，另飛機維修試車及起飛前的溫車產生的噪音，與飛機停靠方向、操作馬力有關，而最大音量產生的方向隨機型設計的不同也有差異。飛

機在無地面動力裝備的機坪試車，就必須使用飛機的輔助動力裝備，其噪音量大小與發動機、操作狀態、持續時間有關，其他如電源車、油罐車等車輛本身噪音外，尚有動力機械之噪音等等。

地面動力裝備、電源車、氣源車及輸送設施等作業噪音特性為連續且變化平穩，其頻率特性與機械設備類似。

參、噪音整合模式

為了瞭解機場周圍大範圍地區噪音影響的程度，如果需使用實測噪音數據繪製，就必須取得更多的噪音數據，如此繪製出的等噪音線圖方能趨近於實際現況，但不是機場周圍每一處均無遮蔽物或反射物，完全符合國際標準規範的量測條件，可供作為監測點，且受限於設置成本，目前各國多以有限的監測點量得之數據，配合飛機操作程序、飛航狀況以及起降頻率等結合電腦模式，繪製出等噪音線圖，依照機場周圍地區航空噪音防制辦法第三條規定，等噪音線係將全年飛航資料，輸入美國航空總署研發之整合噪音模式(INM)所繪製之封閉曲線。

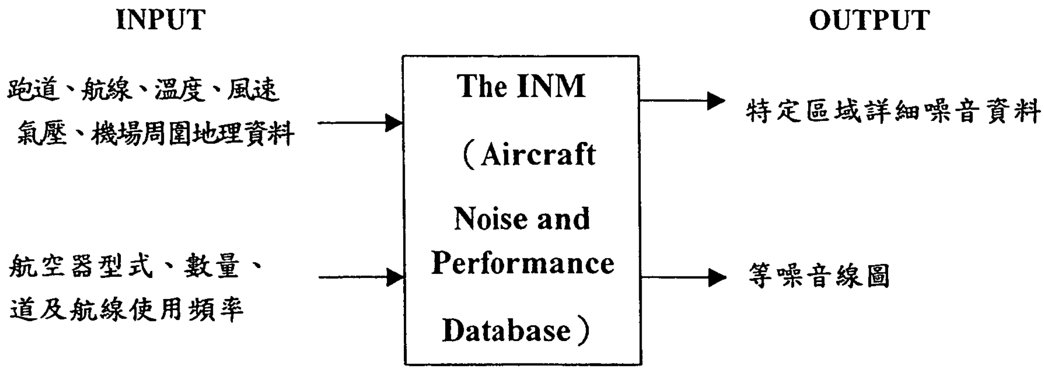
噪音整合模式（INM, Integrated Noise Model）為美國航空聯邦總署（FAA, Federal Aviation Administration）所發展用來模擬各機場航空噪音。具

官方認可的航空噪音評估模式，並廣為各機場噪音管理單位使用，各機場跑道、標高、方向、氣溫等地理條件不同，起降的航空器、使用的航線等均有所差異，所以該模式提供與噪音影響有關的輸入參數資料庫，包含：

1. 機場名稱、程式檔名等識別定義。
2. 跑道座標定義，如跑道空間座標位置、傾斜角度、標高。
3. 氣溫，以年平均溫表示。
4. 特定機場起降的航空器型式，如不在該模式提供的標準資料庫中，即需另外選擇重量、發動機型式類似的航空器。
5. 飛行剖面參數，如距離、高度、速度、馬力等。
6. 噪音曲線，在某一特定高度、速度下的噪音量，模式提供 PNL、dB(A)等兩種計算參數，可用以推估 DNL、NEF、WECPNL、CNR 等評估指標的等噪音線。
7. 起飛、降落、衝場頻率，須定義各種不同的航線、各種航空器使用各航線的頻率，該頻率係依航空器型別分別計算全年使用特定航線的總架次之有效日平均。

適用於商用機、一般機及軍用機等固定異飛機之噪

音模擬，包括航空器空中及地面滑行、試車等噪音資料，更可針對特定區域顯示其噪音暴露量之影響。



一、INM 評估指標：

（一）A 加權噪音指標（A-weightted noise Metrics）

1. DNL 航空噪音日夜音量

$$Ldn = 10Log\left[\frac{1}{86400}\sum_{J=I}^{N}10^{((L_{ABJ}+P_J)/10)}\right]$$

2. CNEL 社區噪音均能音量

$$CNEL = SENL + 10LogN - 49.4$$
$$SENL = L\max + 10Logt/2$$

3. LAEQ 24 小時均能音量

$$Leq = 10Log\frac{1}{T_0}\int_0^T\left(\frac{Pt}{Po}\right)^2 dt$$

4. LAEQD 日間均能音量（07:00-22;00）

5. LAEQN 夜間均能音量（22:00-07:00）

6. SEL 噪音暴露為準

$$L_{AE} = 10Log\left[\frac{1}{T_0}\sum_{t=1}^{N}10^{(L_{At}/10)}\Delta t\right]$$

7. LAMAX 噪音最大位準

8. TALA 超過噪音為準限值之時間

（二）聲頻修正覺察噪音指標（Tone-corrected perceived-noise Metrics）

1. NEF 噪音暴露預測

$$NEF = EPNL + 10LogN_t - 88$$

2. WECPNL 加權等效持續覺察位準

$$WECPNL = dB(A) + 10LogN - 27$$

3. EPNL 有效覺察噪音位準

$$L_{EPN} = 10Log(\frac{1}{T_0}\sum_{i=1}^{n} 10^{(L_{PN,i}+TC_i)10} \Delta t)$$

4. PNLTM 最大 PNLT 噪音位準

5. TAPNL 超過 PNLT 限值之時間

Metric Type	A-Weighting	C-Weighting	Tone-corrected perceived-noise
Exposurebase	DNL	CEXP	NEF
Exposurebase	CNEL		WECPNL
Exposurebase	LAEQ		EPNL
Exposurebase	LAEQD		
Exposurebase	LAEQN		
Exposurebase	SEL		
MAX. Level	LMAX	LCMAX	PNTLM
Time Above	TALA	TALC	TAPNL

二、INM 輸入相關參數

（一）機場物理特性

1. 機場基本資料：

寬度、長度、高程、溫度、風速、氣壓、機場周圍地理資料。

2. 跑道基本資料：

跑道座標（X、Y 座標）、跑道長度、寬度、高程、傾斜角度、起飛端點、進場終點等資料。

INM 跑道長度分類表

Stage Length	Trip Distance
1	0 to 500 nmi
2	500 to 1000 nmi
3	1000 to 1500 nmi
4	1500 to 2500 nmi
5	2500 to 3500nmi
6	3500 to 4500nmi
7	More than 4500 nmi

（二）航線特性

航線名稱、航線分佈情形、跑道名稱、直

飛距離、轉彎方向及角度、轉彎弧度。

（三）控制因素

1. 航空器型式

機型名稱、引擎型式及數量、噪音資料庫、空重、起飛及降落之總重，載客或貨運機等資料。

2. 定義替代機種（噪音資料庫以外之機型）

INM6.0 版共提供 226 飛機之噪音資料庫，噪音資料庫中沒有的機種需從其所提供之噪音資料庫中替代機種。

3. 定義噪音曲線（系統未提供者）

利用飛機所使用馬力，換算成造音量。

（四）跑道及航線使用率

1. 航空器進、離場程序

使用航空器之型式，其作業狀態為起飛、進場或衝場，使用的何條跑道。

2. 離場、降落及衝場航線及使用架次或頻率

日間架次、夜間架次、跑道及各航線所使用之頻率。

（五）等噪音線圖輸出

1. 選用等噪音線圖噪音指標

選擇要使用之噪音評估指標，俾利繪製等

噪音線圖。

2. 定義比例尺及等噪音線數量

選擇所需之等噪音線圖輸出樣式、比例及等噪音線數量，套繪於電子地圖上（包括人口資料等），即可顯示機場周圍地區敏感受體所受航空噪音影響程度。

肆、未來展望

民眾對機場周圍地區的航空噪音之要求日益嚴格。現在台灣地區機場周圍已大部分設置自動噪音監測系統，提昇整合噪音模式繪製等噪音線圖之技術，以做為環保單位進行航空噪音管制之依據。

INM Training Course Notes

Prepared by HARRIS MILLER MILLER & HANSON INC.

in cooperation with SENZIG ENGINEERING

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Session 1. Review of Airport Noise Terminology

Session Goals:

To understand the metrics commonly used to assess airport noise, and to explore how the computer program calculations work through investigation of:

✈ definitions and inter-relation of various metrics;

and

✈ calculation processes inside the INM.

A Historical Perspective

The late 1950's ushered in a new level of speed, comfort and convenience in air travel: the first commercial jet airliner With this new technology came a new level of community response to aircraft noise Compared with its piston-engine, propeller-driven predecessor, the turbojet-powered transport represented a dramatic difference in both the character and loudness of aircraft activity heard by airport neighbors. The broadband jet noises during takeoff, and the high-pitched compressor "whine" during landing, were unlike anything produced by the propeller-driven aircraft. Almost overnight, aircraft noise was thrust into the forefront of environmental concern.

Over the next two decades, intensified government and private sector research would identify and quantify many of the jet noise attributes that contribute to human annoyance and community reaction. The fruits of this research would be invested in aircraft noise certification regulations (to quiet the noise at its source), land use compatibility guidelines, and prediction tools, such as the Integrated Noise Model (INM), to give planners the means to forecast and evaluate the effects of proposed actions before they were undertaken.

During the basic research years of the 1960s and 1970s, aircraft noise listening tests and case history studies pursued several important objectives. One objective was a better understanding of how people compare the relative loudness of different complex, aircraft sounds. The goal was a sound measurement scale that better correlated with human assessment of relative loudness than the A-level. If two relatively steady-state sounds were perceived as equally loud, the measurement scale should give them near-equal numerical ratings. Likewise, if one sound was perceived to be louder than another it should receive the numerically higher scale rating. The *perceived noise level* and the *tone-corrected perceived noise level*, now international standards for aircraft noise certification purposes, are two important measurement scales borne out this research.

During this period, the sound from an aircraft pass-by was simply rated by its maximum sound level. Intuition, however, suggested the dimension of time also played a role in the human perception of noisiness. Conventional wisdom asserted that shorter duration flybys would be perceived as less noisy than longer ones, all other things (including their maximum sound level) being equal A second area of research investigated how human observers subjectively combine the "duration" of noise intrusions with the maximum sound level to assess the comparative "noisiness" of two or more events.

The research goal was an advanced scale by which single aircraft noise intrusions could be measured and compared with one another in a way that correlated better with subjective assessments than did the maximum sound level alone. For example, if two pass-bys sounded equally noisy the scale should produce very similar numeric values. On the other hand, if one pass-by sounded noisier than another it should have the higher scale reading. The *effective perceived noise level*, and later the *sound exposure level* metrics are products of this research.

A third avenue of research was the investigation of factors influencing human observers' assessment of noise exposure over an entire 24_hour day. A daily measure offered promise of a powerful tool for achieving several objectives: comparing noise exposure between neighborhoods, setting policy and guidelines for compatible land use near airports, and (with the proper modeling tools) forecasting the impact of alternative operational scenarios. Factors hypothesized to be important included the daily numbers of aircraft noise intrusions, their relative noisiness, and the time of day they occurred. The building blocks were already in place and the time was right.

With similar research being conducted worldwide, it comes as little surprise that this effort produced a variety of single-number rating scales for 24_hour exposure (composite noise rating, noise exposure forecast, day-night average sound level, noise and number index to name a few) They all use one of the single event metrics as the basic building block, but differ in the mathematics of how single event energy is accumulated over the day, and the relative single event *weightings* (or *penalties*) applied at different times of day.

Noise Scale Families

There *is* order to this array of scales, however. For each measure of daily noise exposure there is only *one* underlying measure of single event noisiness. Similarly, any particular single-event noisiness measure uses only *one* scale for the moment-to-moment measurement of sound level. Hence, the descriptors can be thought of as belonging to families, and the INM incorporates the needed databases and computational procedures so that the user may select the family of choice. Sixteen predefined metrics are provided with INM Version 6. User-defined metrics can also be added.

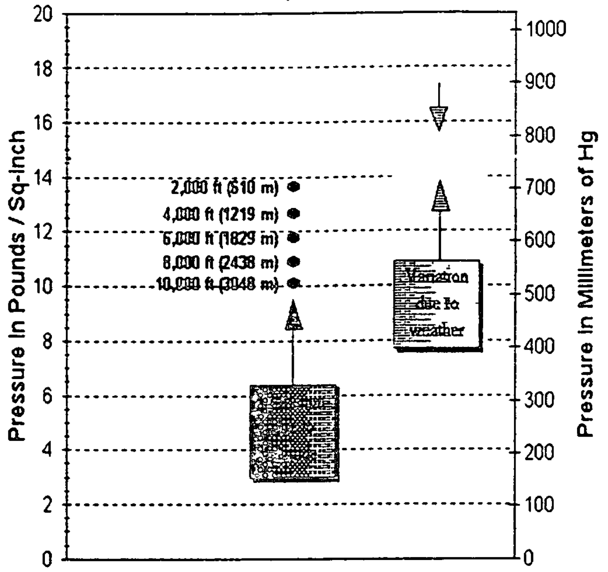
In the remainder of this section, we will start by reviewing some fundamental principles of sound, followed by a description of single event and daily sound measurement scales. Detailed calculation procedures will be presented. The INM incorporates these procedures in its computational algorithms. It is important for the model user to understand the basic calculation process in order to properly apply and use the model's full capability and range of outputs. Exercises are included to illustrate the calculation procedures. The exercises also serve to indicate how frequently encountered "what if" questions with regard to these metrics can be addressed.

Sound Pressure

The phenomenon we experience as sound is small pressure fluctuations in the air around us. On the scale of normal atmospheric pressure changes they are microscopic. But within this microscopic world the sensitivity of the human auditory system spans an enormous range. How small these fluctuations are will be seen in the next four figures.

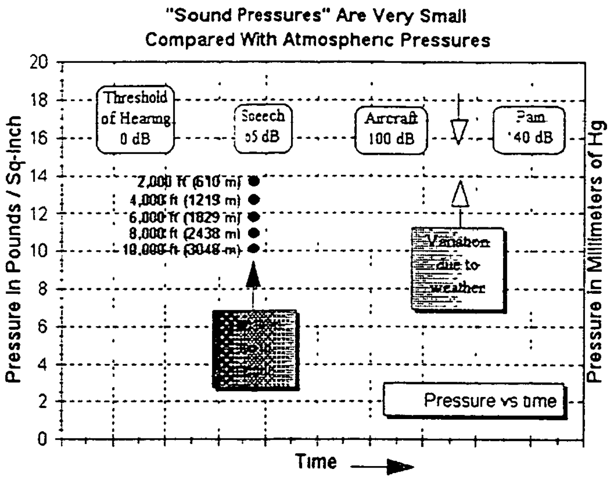
We live at the bottom of a deep ocean of air. At sea level, air pressure averages about 14.7 pounds per square inch (psi) or 760 mm of mercury (mm Hg). During stormy weather the pressure can drop by ½ to ¾ psi (26 to 39 mm Hg), and during fair weather can increase by the same amount. These weather-related pressure changes are shown in the figure below.

Common Atmospheric Pressures



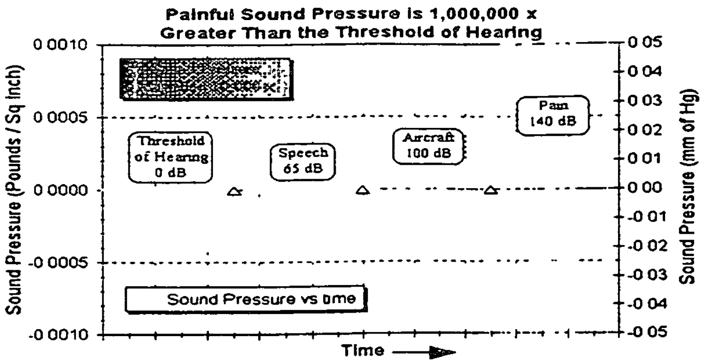
We do not perceive weather-related pressure changes with our ears because they happen so slowly. On the other hand, this figure also shows that the magnitude of these changes is about the same as a 1000-foot (305 meter) change in elevation. Experience tells us that if this change is made rapidly enough, such as in an airplane or on a steep mountain highway, our ears do notice the change. While this phenomenon is not the same as hearing in the classical sense, it does illustrate the sensitivity of the ear to pressure *change*.

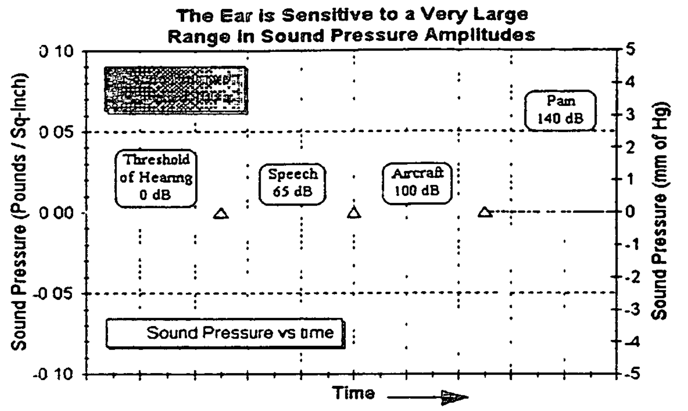
The information in the first figure is repeated in the next figure, which plots pressure (on the vertical scale) as a function of time (on the horizontal scale). The pressure trace is divided into four time intervals, identified by the three triangles along the trace. The left side of the graph shows the pressure fluctuations of the faintest sound a young healthy human can hear, 0 decibels (dB). At this scale, such small pressure fluctuations are not visible. In the second quarter, the pressure fluctuations associated with normal speech (about 65 decibels at a distance of one meter) have been superimposed onto atmospheric pressure. Once again, these pressure fluctuations are so small that they do not even show at this scale. The same is true in the third quarter of the trace where the pressure fluctuations associated with a 100-decibel noise are superimposed. Finally, in the fourth quarter of the trace, the pressure fluctuations from a 140-decibel sound, enough to evoke the sensation of pain, are barely perceptible.



At the pressure scale shown in the second figure, only the 140 decibel sound pressure fluctuations are visible, an indication of just how small even loud sound pressure fluctuations really are. These pressure *differences* about atmospheric pressure are referred to as sound pressure. Sound pressures are measured as if the ambient atmospheric pressure were the zero line, with pressures above atmospheric considered positive, and pressures below atmospheric, negative.

The first figure below magnifies the vertical scale of the second figure by a factor of 100 It also shows the sound pressure fluctuating about a zero reference line. At this scale, the sound pressure of the 140-decibel sound is clearly shown, but the 100-decibel aircraft is just perceptible. The speech at 65 decibels is not perceptible.





In the final figure, the vertical scale is magnified yet another 100 times (10,000 times the second figure) and the speech at 65 dB is now just perceptible. To complete the picture, the smallest sound a healthy human can detect is near 0 decibels. For that sound pressure to be perceptible on this type of graph, the vertical scale would have to be magnified another 1,000 times over that shown in the final figure.

rms Sound Pressure

To quantify the sound pressure fluctuations shown in the preceding figures we use a quantity called the root mean square (rms) sound pressure. Literally, this is the square root of the average squared sound pressure. The average is taken over some small period of time (about 1 second for aircraft noise purposes). Equation 1 shows the mathematical process used by modern digital sound level meters to calculate the rms sound pressure.

$$p_{rms} = \sqrt{\frac{1}{N}\sum_{i=1}^{N} p_i^2}$$

Eqn. 1

where

p_{rms}

=rms sound pressure

p_i

=sound pressure (deviation from atmospheric) at the i^{th} sample

p_i^2

=the square of the i^{th} sound pressure

N

=number of samples (many thousands) over a 1 second period

Note that p_i can take on both positive and negative values. By squaring the sound pressure, every term in the summation becomes positive, thus assuring a positive sum. Dividing the sum by N yields the average *squared* sound pressure, and taking the square root brings the units back to pressure. The result is the rms sound pressure.

The examples in the previous figures illustrated just how large a range in sound pressures the human auditory system is capable of sensing, from the barely perceptible to the threshold of pain. If a pressure of 1 represented the faintest audible sound, then the threshold of pain would be represented by a pressure of 10,000,000! The decibel scale used in the measurement of sound (and discussed in the next section) serves to collapse this range to 0 to 140.

rms Sound Pressure Level

The rms sound pressure *level* (often abbreviated to "rms sound level" or just "sound level") is the decibel equivalent of the rms sound pressure. Equation 2 shows how the rms sound pressure level is calculated

$$L_p = 10\,Log_{10}\left[\frac{p_{rms}^2}{p_0^2}\right] \qquad \text{Eqn. 2}$$

where L_p =rms sound pressure level
p_{rms} =rms sound pressure
p_o =reference pressure of 20 x 10^{-6} N/m^2 or 2.90 x 10^{-9} lb/in^2
Log_{10} =base 10 logarithm

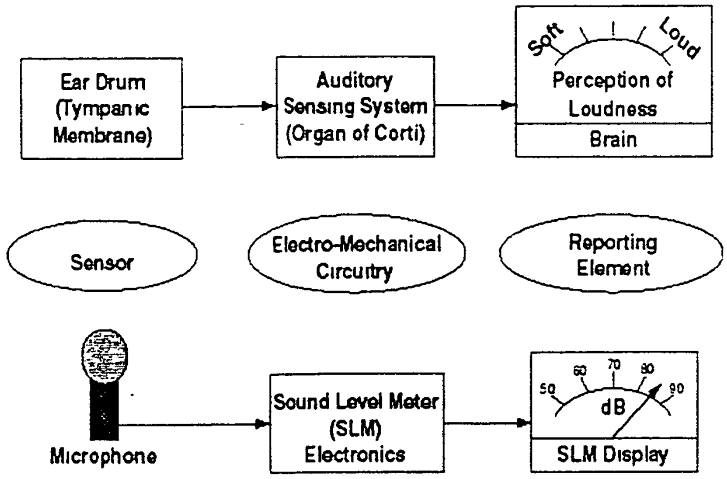
The value of p_0 has been chosen to approximate the lowest rms sound pressure detectable by a healthy young adult. The metric units, N/m^2, are Newtons (force) per square meter (area), and the English units lb/in^2, are pounds (force) per square inch (area). If the value p_0 is substituted in place of prms in Equation 2, L_p evaluates to 0 dB. If 200 x 10^{-6} N/m^2 is substituted for prms, then L_p evaluates to 20 dB.

- a 10 decibel increase is subjectively interpreted as a doubling of loudness (and a 10 decibel decrease is interpreted as a halving of loudness), and
- changes of less than 2 or 3 decibels are not readily detectable outside of a laboratory environment

Pitch and the A-weighted Sound Level

An interesting facet of the human auditory system is its unequal perception of loudness when two sounds of equal sound pressure level, but differing pitch, are heard. To explore this phenomenon, the upper portion of the figure below shows a cut-away view of human auditory system. A sound level meter block diagram is shown in the lower portion of the figure.

Relationship Between Sound Level Meter and Human Auditory System



There are three important components to both systems. The first is the sound pressure sensing element, the eardrum (tympanic membrane) in the human system, and the thin microphone diaphragm in the sound level meter. Both are held tightly in place, and both vibrate by minute amounts as sound pressure impinges on them.

In the second element the mechanical motion of the sensor is converted to an electrical signal or impulse. The middle ear bones and the organ of corti perform this function in the human system, and an electrical amplifier does so in the sound level meter.

In the third element a response indicator presents the resulting electrical impulses, or signals. In the human auditory system, the brain creates the perception of loudness. In the sound level meter it is a visual display.

There is an important distinction between the two systems in the behavior of the middle component. Within the mechanical limits of the microphone, sounds of equal sound pressure level, but differing pitch, register the same reading on the meter. That is, the measuring system is equally sensitive to all pitches of audible sound. Within the human auditory system, however, the pitch, or technically, the *frequency* of the sound plays an important role in the interpretation of loudness. At equal sound pressure levels, low frequencies are perceived as less loud than middle frequencies in the 1,000 to 4,000 Hz range. At frequencies above 4,000 Hz, sensitivity decreases.

In addition to influencing how we perceive the loudness of sounds, the frequency content of the sound influences how the sound propagates through the atmosphere. Low frequency sounds propagation better than high frequencies. We will discuss this in detail in Session Four.

Sound level meters are equipped to approximate the response of the human auditory system by incorporating an electrical filter into the amplifier. The filter characteristics are shown in the figure on the next page. The curve plots system sensitivity on the vertical axis against frequency (pitch) on the horizontal axis Zero on the vertical axis is arbitrarily referenced to the sensitivity of the human auditory system at 1000 Hz. Note that at 50 Hz the filter is approximately 30 decibels less sensitive than at 1000 Hz, and at 250 Hz it is approximately 9 decibels less sensitive than at 1000 Hz. This electrical circuit is called the "A_weighting" filter. It is an international standard incorporated in all sound level meters used for environmental analyses.

Using this filter, two sounds of differing pitch (but equal sound pressure level) will read differently on the meter in a way that is similar to the difference in perception of loudness by a human observer. Said another way, two sounds of equal A_weighted sound level will be perceived near equal in loudness by a human observer.

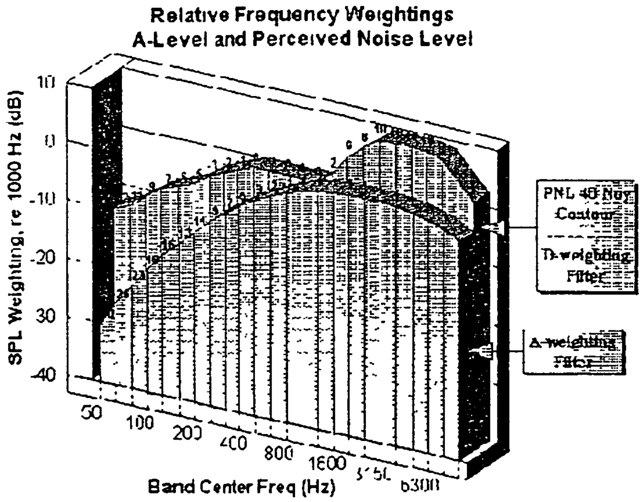
To distinguish the A_weighted meter readings from any other, they are referred to as the A_weighted sound level, often abbreviated to just A_level. The units are decibels, as in an A_weighted sound level of "80 decibels " In the literature it is common to find reference to a sound level of "80 dB(A)" or "80 dBA." Although the latter two examples do not conform to current terminology standards, they all imply the A_weighted sound level in decibels.

The FAA introduced the ability to calculate C-weighted sound levels with version 6.0 of the INM. These C-weighted metrics are the LCMAX, the CEXP, and the TALC. These correspond to, respectively, the LAMAX, the SEL and the TALA A-weighted metrics. C-weighted metrics are discussed in greater detail in Session Four.

Perceived Noise Level

The perceived noise level (PNL) is a quantity similar to the A-weighted sound level. It is a time-varying quantity like the A-weighted sound level. The calculation was meant to be performed by digital computer. Until the advent of digital sound level meters, the complexity of measuring the perceived noise level precluded its incorporation in any portable sound level meter. While the perceived noise level scale was acknowledged to show somewhat better correlation with human perception of complex noises than Alevel, the difficulty in performing simple, inexpensive field measurements relegated its use to specialized applications. For example, the perceived noise level has been adopted internationally for use in noise certification of new aircraft.

The calculation method is shown here to illustrate the vast difference in computational complexity compared with the Aweighted sound level. Briefly, the calculation involves simultaneous sound level measurements through 24 one-third octave band filters, ranging in center frequency from 50 Hz to 10,000 Hz. The reading in decibels from each band is converted to a value in *noys* using frequency weightings and non-linear "noisiness growth functions" unique to each frequency band. The effective frequency weighting function is compared with the Aweighting function in the figure below.



The noy values from all frequency bands are then summed as shown in Equation 3.

$$\sum N = N_{50} + N_{63} + N_{80} + \ldots + N_{10\,000}$$

Eqn. 3

where

$\sum N$

=the summed noy value across all 24 frequency bands

N_{50}

=the noy value in the 50 Hz one-third octave band

N_{63}

= the noy value in the 63 Hz one-third octave band

$N_{10,000}$

=the noy value in the 10,000 Hz one-third octave band

If the summed noy value were then converted back to decibels the process would be only moderately complex. However, a *total* noy value is then calculated by extracting the highest noy value from the sum, multiplying the remainder by 0 15, and then adding the highest value back in again as shown in Equation 4:

$$N_T = N_{max} + 0.15 \left(\sum N - N_{max}\right)$$

Eqn. 4

where

L_p

=rms sound pressure level

p_{rms}

=rms sound pressure

p_o

=reference pressure of 20 x 10^{-6} N/m^2 or 2.90 x 10^{-9} lb/in^2

Log_{10}

=base 10 logarithm

The total noy value is then converted to perceived noise level by Equation 5:

$$L_{PN} = 40 + 33.3 \cdot Log_{10}(N_T)$$

Eqn. 5

where

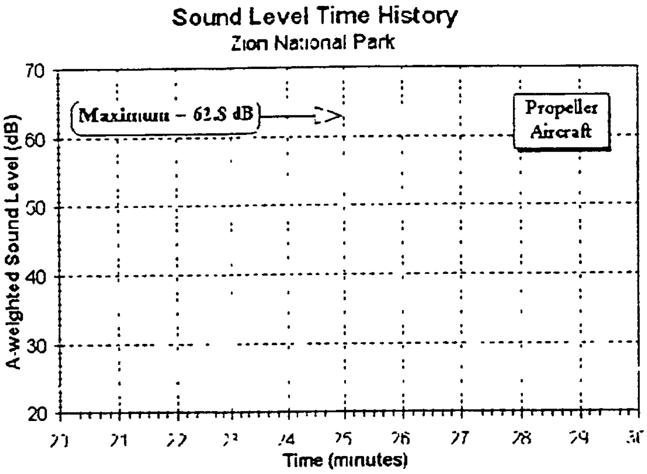
L_{PN}

=the perceived noise level

For most aircraft noise sources the perceived noise level will usually be 13 decibels higher than the A_level, plus or minus one decibel.

Sound Exposure Level

Before the late 1960s, the method used to quantify the sound level of a transient noise event (such as an aircraft flyover) was to cite its maximum A_weighted sound level. The concept is shown in the figure below, which plots a time series of A_weighted sound level readings over a 10 minute period. The sound from a passing aircraft protruding from the background noise is readily observed in this graphic. The highest A_level that was read during the pass by was 62 8 decibels.



Intuitively, however, it was clear that all other things being equal, people would choose the shortest possible duration for an unwanted sound. During the late 1960s and early 1970s, laboratory listening tests were conducted to determine people's willingness to trade between an event's maximum sound level and its duration. Human test subjects were asked to compare the overall "noisiness" of aircraft flybys of differing sound level maximums and durations.

These experiments showed that people were generally willing to accept a 3-decibel increase in maximum level forever halving of the duration for two noise events to be judged equally noisy. This finding supported an equal energy model of noise event noisiness. Equation 6 below expresses this in mathematical terms, and defines the "sound exposure level" calculation. The equal energy formulation allows us to take regular readings (every ½ second) during the aircraft pass by, divide each reading by 10 and take the antilog (i.e. $10^{(\text{sound level} / 10)}$), sum the antilog values, multiply the sum by the time interval (½ second), take the logarithm of the result, and finally multiply by 10 to obtain a result in decibels.

$$L_{AE} = 10\,Log_{10}\left[\frac{1}{T_0}\sum_{i=1}^{N} 10^{(L_{A,i}/10)}\,\Delta t\right]$$

Eqn. 6

where

L_{AE}

=sound exposure level (SEL)

Log_{10}

=base 10 logarithm

T0

=reference time of 1 second

$L_{A,i}$

-individual A-weighted sound level readings during the flyover

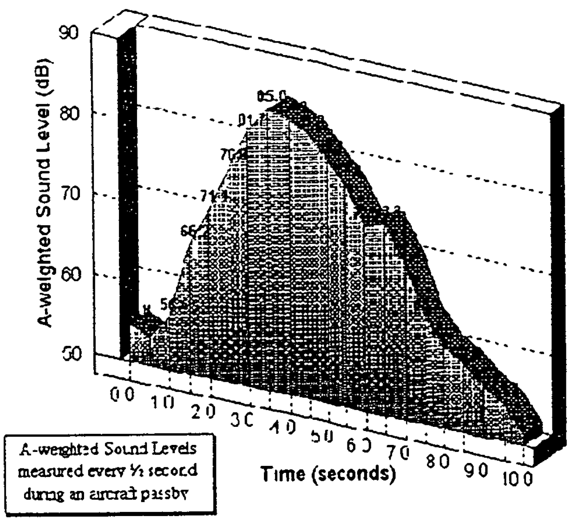
N

=number of sound level readings needed to cover the top 10 to 20 dB of flyover

Δt

=time increment between sound level readings (usually ½ second)

The figure below provides the basis for an example calculation by showing the time history of Aweighted sound levels for an aircraft flyover. The sound levels were determined at ½-second intervals.



The table below presents the sequence of Aweighted sound level readings. The left-hand column of the table shows the time each sound level was read. The second column shows the readings themselves, in decibels. The third column shows the decibel readings converted to an energy form by performing the antilog operation described above. At the bottom of this column the energy values are summed, and the sum then multiplied by ½ (the inter-sample interval). Immediately below is the computed sound exposure level.

Sample Sound Exposure Level (SEL) Calculation

Time (sec) ∆t=0 5	A_weighted ...		Integration over top X decibels		
	SPL (dB)	Energy	Top 5 (80-85)	Top 10 (75-85)	Top 20 (65-85)
0 0	54 8	3 02e+05			
0 5	53 4	2 19e+05			
1 0	56 6	4 57e+05			
1 5	66 2	4 17e+06			4 17e+06
2 0	71 1	1 29e+07			1 29e+07
2.5	76 8	4 79e+07		4 79e+07	4 79e+07
3 0	81 7	1 48e+08	1 48e+08	1 48e+08	1 48e+08
3 5	85.0	3.16e+08	3.16e+08	3.16e+08	3 16e+08
4 0	84.2	2 63e+08	2 63e+08	2 63e+08	2 63e+08
4 5	82.9	1 95e+08	1 95e+08	1 95e+08	1 95e+08
5 0	80 3	1 07e+08	1 07e+08	1 07e+08	1 07e+08
5 5	77 8	6 03e+07		6 03e+07	6 03e+07
6 0	73.1	2.04e+07			2 04e+07
6 5	73 8	2.40e+07			2 40e+07
7 0	69 5	8 91e+06			8 91e+06
7 5	63.2	2 09e+06			
8 0	60 1	1 02e+06			
8 5	58 4	6 92e+05			
9 0	56 3	4 27e+05			
9 5	54 7	2 95e+05			
10 0	51 4	1 38e+05			
Sum		1 21e+09	1 03e+09	1 14e+09	1 21e+09
Sum * ∆t (0 5 sec)		6 07e+08	5 15e+08	5 69e+08	6 04e+08
10 *Log(Sum * ∆t), dB		87.83	87 12	87 55	87 81
Difference from complete SEL (87 83), dB			-0.71	-0.28	-0.02

An important facet of this calculation is the number of readings needed during the pass-by to perform the calculation with acceptable accuracy. The columns on the right side of the table perform the same energy summing operation, but over a more limited range of the complete noise event. The first of these columns uses only those readings that are within the top 5 decibels of the maximum. The sum is less than for the complete pass-by, and the computed SEL is 87.12 decibels (0.71 dB less than the complete pass-by). In the next column, readings within the top 10 decibels are summed. The computed SEL is 87.55 decibels (only 0.28 dB less than the complete pass-by). Finally, in the right-most column sound level readings within the top 20 decibels of the maximum are summed. In this case the computed SEL is 87 81 decibels, only 0.02 dB less than the complete flyover

The relationship between the summation interval and the computed SEL is an important one. The point of the exercise is to illustrate how the summation period needed to obtain an SEL calculation of satisfactory accuracy is determined. Calculating an SEL from the top 20 decibels is near ideal, but a sacrifice of only 0 5 decibel is made if only the top 10 decibels is available Calculating an SEL from only the top 5 decibels is marginally acceptable.

Effective Perceived Noise Level

The parallel to the sound exposure level is the effective perceived noise level (EPNL). Just as a time-series of Aweighted sound levels is used to compute the SEL, a time-series of "tone-corrected" perceived noise levels (PNLT) are used to compute the EPNL. The tone corrected perceived noise level is determined by measuring the perceived noise level as illustrated in the previous subsection, and adding to that value a "pure-tone" correction of up to 6 decibels.

Early turbojet/ turbofan engines emitted strong, high-frequency tones generated by the compressor stages of the turbine engine. The 1970's research examined how people assessed the relative loudness of broadband aircraft sounds with and without pure tones embedded in them. In general, people felt that pure tones were subjectively louder than broadband noise at the same frequency. Since the perceived noise level scale had been developed using broadband noise experiments, a method for incorporating the increased noisiness of pure tones was needed.

The exact algorithm is beyond the scope of this text, but the tone correction is frequency dependent, and a function of the tones intensity above adjacent frequency bands. The method used to calculate the EPNL is shown in Equation 7. Perceived noise level and tone correction values are determined every ½_second and summed by·

$$L_{EPN} = 10 \cdot Log_{10}\left(\frac{1}{T_0}\sum_{i=1}^{N} 10^{(L_{PN,i}+TC_i)/10}\,\Delta t\right)$$

Eqn. 7

where

L_{EPN}
=effective perceived noise level

$L_{PN,i}$
=instantaneous ith perceived noise level

TC_i
=instantaneous ith tone correction

Δt
=0 5 seconds (between samples)

T_0
=10 seconds

and Limits of i from 1 to N are sufficient to sum over the top 10 PNdB of the noise event

The effective perceived noise level is an international standard for the noise certification of new aircraft. The EPNL and the aircraft's certified gross weight are used to determine compliance with regulatory limits.

Day/Night Average Sound Level

Laboratory experiments were understandably impractical for developing a mathematical noise exposure model that would correlate with peoples' attitudes about the noise environment over a complete 24_hour period. Instead, case history information about neighborhood reaction to aircraft noise was used to formulate a relationship between the numbers of noise events people would accept versus the sound exposure level of these events. The conclusion reached was that an equal energy trading relationship, virtually identical to the relationship between noise event duration and maximum sound level, was both reasonable and convenient. The hypothesis states that people are willing to trade an increase of 3 decibels in flyover SEL for a halving of the number of noise events during the day, all other things being equal.

Just as the SEL computation sums individual sound level readings over the duration of the noise event, the Day Night Average Sound Level sums individual flyover SELs over the day. One additional consideration is the treatment of nighttime noise events (in the United States, "nighttime" extends from 10pm to 7am). The DNL calculation weights these noise events by adding an additional 10 decibels to the SEL as the summation process of Equation 8 takes place. The units of DNL are decibels.

$$L_{dn} = 10\,Log_{10}\left[\frac{1}{86{,}400}\sum_{j=1}^{N} 10^{(L_{AE_j}+P_j)/10}\right]$$

Eqn. 7

or

$$L_{dn} = 10\,Log_{10}\left[\sum_{j=1}^{N} 10^{(L_{AE_j}+P_j)/10}\right] - 49.37$$

Eqn. 8

where

L_{dn}

=day/night average sound level (abbreviated DNL in text)

Log_{10}

=base 10 logarithm

86,400

=number of seconds iin a day

N

=number of sound exposure level (SEL) readings during the day

L_{AEj}

=individual SEL readings during the day

P_j

=time of day weighting for the *jth* SEL reading

Conceptually, the DNL represents the total accumulation of all noise energy, but spread out uniformly over a 24_hour period (the division by 86,400, the number of seconds in a day, performs this function in the equation) In the aircraft noise world, this averaging process has lead to considerable misunderstanding. The often-cited complaint is "It's the high noise levels that annoy me, not the average!" The relatively low numbers on the DNL scale do not seem to convey the magnitude of the noise problem stated by the numerically higher SELs or maximum Alevels Equation 8 shows us that, in fact, all of the aircraft noise energy has been accounted for; it is simply the division by a large constant that makes the resulting DNL values seem disconcertingly small.

The behavior of the DNL to specific changes in noise climate, however, demonstrates its sensitivity to subjectively important factors. For example, if all the aircraft noise levels are increased by 10 decibels, the DNL increases by 10 decibels as well. If one particularly noisy event occurs, it will by itself raise the DNL. If the number of aircraft operations is doubled, the DNL increases by 3 decibels.

Useful rules of thumb regarding DNL are:

- All other things being equal, a doubling in the number of aircraft operations increases the DNL by 3 decibels (a halving *decreases* the DNL by 3 decibels),

- The DNL contribution of a single aircraft noise event can be estimated by subtracting 50 from the time-of-day-weighted sound exposure level (this convenient figure arises from the averaging process in Equation 8, $10 \text{ Log}_{10} [86{,}400] = 49.37$, or approximately 50 dB).

- A few noisy nighttime events (such as re-certified Stage 2/Chapter 2 aircraft departures) can dominate the day's DNL at all but the busiest airports.

As an illustrative exercise, the table below shows a series of sound exposure level readings near an airport. The left-hand column of the table identifies the time of day each noise event occurred. The next column identifies the aircraft type (for completeness, but not necessary for determining the DNL for the day). The next column tabulates the measured noise event SEL. In the fourth column the time of day weighting is entered (7am to 10pm has a 0 dB weighting, and 10pm to 7am gets a 10 dB weighting). In the fifth column the SEL and the weighting are added together, and in the sixth column this sum is divided by 10 and the antilog taken. The numbers in this last column are then summed, the sum divided by 86,400, and result converted back to decibels.

Sample Day-Night Average Sound Level (DNL) Calculation

Time of Day	Aircraft Type	Sound Exposure Level (dB)	Time of Day Wtg (dB)	Wt'd SEL (dB)	Energy
6 05am	MD80	84 3	10	94 3	2 69e+09
8 23am	B727	93 6	0	93 6	2.29e+09
10 28am	B737-300	82 6	0	82 6	1 82e+08
12 48pm	B737-200	90 3	0	90 3	1 07e+09
5 37pm	B727	94 8	0	94.8	3.02e+09
9·45pm	MD80	86 1	0	86 1	4 07e+08
10 07pm	MD80	85 2	10	95 2	3.31e+09
			Energy Sum		1 30e+10
			Divide by 86,400		1 50e+05
			DNL		**51.8**

When the Integrated Noise Model calculates the DNL at a single point on the ground, it determines the SEL for each aircraft and performs the summation process according to Equation 4. In Session 2, in the discussion of the integration of the various noise and performance profiles, we provide a step-by-step description of how the INM determines SEL.

Exercise 1: Calculation of DNL from SEL Values

The Workbook contains a table similar to that on the preceding page, in which you will fill in numbers to calculate DNL from a set of noise events.

Part A

Step ❶ Fill in the Time of Day Weighting (T-o-D Wtng) column with the appropriate weightings, depending on whether the flight occurred during the day or night.

Step ❷ Fill in the Weighted SEL column by adding the SEL to the Weighting.

Step ❸ Calculate the effective noise energy for each event by dividing the weighted SEL by 10, and then taking 10 to that power. Fill in the top portion of column A with these results.

Step ❹ Add the noise energy values you have listed in column A, and record your sum in the bottom portion of that column.

Step ❺ Divide your sum by 86,400 (the number of seconds in a day, used because SEL is normalized to 1 second) and record the result.

Step ❻ Convert the energy to "Bels" by taking the logarithm (base 10) of your result after the division, and record your answer.

Step ❼ Multiply that answer by 10 to convert to deciBels. This is the DNL.

Parts B (and C)
Copy and sum the noise energy (listed in column A) from only the departure (or arrival) events; list your answers in column B (or C). Then follow steps 5 through 7 as described above to get partial DNL corresponding to departure (or arrival) noise alone.

Part D
Copy and sum the noise energy (listed in column A) from only the day (or night) events; list your answers in column DD (or DN). Then follow steps 5 through 7 as described above to get partial DNL corresponding to daytime (or nighttime) noise alone. Answer question D.

Part E
Answer question E by choosing the event with the highest corresponding value from column A. Is this the event with the highest SEL? What is the partial DNL resulting from this event alone?

Part F
Calculate the partial DNL resulting from all events except the one identified in Part E.

Other 24-hour Scales

The A-weighted sound level, the Sound Exposure Level (SEL) and the Day-Night Average Sound Level (DNL) were used in this section to demonstrate the concept of a family of measurement scales. The first scale in the family is used for moment-to-moment sound level measurements. The second scale is used to quantify the sound exposure for an entire noise event (such as an aircraft pass-by), and the third for quantifying the cumulative noise over a 24_hour day. This family of scales is used in the United States for most environmental and land-use planning studies. Globally, however, there are many more measurement scales in use.

The table below provides a brief sampling of a few 24-hour scales. The first is the day-night average sound level (DNL). The second is the community noise equivalent level (CNEL). CNEL differs from the DNL in the weighting of evening noise events: a multiplier of 3 is applied to events occurring between 7:00 pm and 10:00 pm, which is equivalent to adding a weighting of 4.77 dB to the SEL of each evening event. No weighting is applied to evening events in the calculation of DNL. Both DNL and CNEL use sound exposure level as the single event scale. The noise exposure forecast (NEF) uses effective perceived noise level as the single event measurement scale. NEF uses the same definition of daytime and nighttime periods as DNL, but a greater weighting factor (12.23 dB, or a multiplier of 16.7) is applied to noise events at night.

Sampling of Different 24-hour Noise Measurement Scales

24-hr metric	single event metric	Hours		Weighting	Multiplier
DNL	SEL	Day	7am to 10pm	0 dB	1
		Night	10pm to 7am	10 dB	10
CNEL	SEL	Day	7am to 7pm	0 dB	1
		Eve	7 pm to 10pm	4 77 dB	3
		Night	10pm to 7am	10 dB	10
NEF	EPNL	Day	7am to 10pm	0 dB	1
		Night	10pm to 7am	12 23 dB	16.7
LDEN	SEL	Day	7am to 7pm	0 dB	1
		Eve	7 pm to 10pm	5 dB	3 16
		Night	10pm to 7am	10 dB	10
ANEF	EPNL	Day	7am to 10pm	0 dB	1
		Night	10pm to 7am	6 02 dB	4

Other Types of Noise Metrics

In addition to Exposure-Based Metrics, which include SEL, EPNL, and all of the various cumulative noise metrics built from combining SEL or EPNL values, the INM has the capability to produce calculations of maximum noise level and calculations of the amount of time the noise is above a specified decibel level.

As described earlier, both SEL and EPNL take the magnitude and the duration of a noise event into account. The other Exposure-Based metrics, because they use SEL or EPNL as a basis, also include magnitude and duration factors. In contrast, Maximum Level metrics measure only the magnitude of the noise, while Time-Above metrics focus only on the (combined) duration of noise events (using a specified decibel level threshold).

In the calculation of Exposure-Based Metrics, the INM uses a set of tables of noise-power-distance (NPD) data that specify SEL or EPNL values for a series of distances for a given engine thrust value. The Maximum Level metrics use NPD data tables of maximum A-weighted sound levels (LAMAX) or maximum tone-corrected perceived noise levels (PNLTM). The Time-Above metrics use both types of NPD curves in order to derive a surrogate noise event duration.

The INM Technical Manual provides detail on the methodology used by the INM in the calculation of all of its pre-defined noise metrics. The user may define different metrics built from either the A-weighted NPD data (SEL, LAMAX), C-weighted data (CEXP, LCMAX) or the Tone-corrected perceived NPD data (EPNL, PNLTM) by applying the same principles but using different weighting factors (multipliers) and different time-averaging constants.

Session 2. Airport Noise Modeling Basics

Session Goals:

To understand the integration of the components inherent in airport noise by modeling by examining:

- types of input and output information;

  and

- synthesis of noise level predictions from input data elements.

This session will provide a review of the fundamental issues involved in developing noise contours. Topics will include: INM input and output, computational algorithms, data collection, and precision requirements

Recent Evolution of the INM

In the last several years, the Integrated Noise Model (INM) has undergone a number of modifications to both acoustical algorithms and data bases. It may be useful to you to understand these differences:

Version 3.9 was released by the FAA in May of 1987 as an update to Version 2.7. Model input was in ASCII text file format.

Version 3.10 was released by the FAA in June of 1992. Version 3.10 included updated noise and performance data for *all* aircraft included in the previous database, and included eighteen *new* aircraft types. There were no computational changes between Versions 3.9 and 3.10.

Version 4.11 was released in December of 1993 This version of the model included noise calculation improvements, an expanded database (with six additional aircraft types, but with *no changes* to the data already listed in database 10), and incorporated algorithms that alter aircraft performance assumptions (and, hence, noise) depending on user-defined temperature and airport elevation parameters.

Version 5.0 was released in August 1995 Major enhancements included: a new graphics user interface, new data preparation and data input aids, new graphics and plotting capabilities, and improved and faster noise calculation algorithms. INM5.0 input files were in the form of a set of database and binary files, as opposed to ASCII text files as in the previous versions. **Version 5.01**, providing a limited number of corrections to bugs found in version 5.0, was distributed in December 1995

Version 5.1 was released in February 1997. Major improvements included incorporation of parts of the preprocessor program and access to NOISEMAP data as well as fixes to problems with Version 5.01. Version 5.1 is compatible with Windows 95 and with Windows NT, but not with older versions of Windows. Version 5.1 also incorporated new and updated database files. Files created with Version 5.0/5.01 need to be converted before being used by 5.1.

Version 5.1a contained several corrections to version 5.1 and was released in May of 1997.

Version 5.2 was released in May 1998. Three new aircraft were added to the database and twenty new substitution aircraft were added. Data for four aircraft were modified to correct various problems. Corrections were made to the conversion program from 4.11 to 5 2.

Version 5.2a was released in February 1999 It contained new noise and performance data for DC9 aircraft with hushkits (Stage 3), and the Embraer 145 It also provided fixes to a few program bugs.

Version 6.0 was released in October 1999. This was the first release in a new series of the INM. It includes one new aircraft type and many algorithm improvements. It utilizes a new version of NMPlot and adds several new options to the model

Version 6.0a was released in May 2000. This was the first minor release in the INM6 series; it added noise and performance data for the Airbus 340 and Embraer 120, as well as a series of bug fixes to the version 6.0 release.

Version 6.0b was released in January 2001 This second minor release of the INM6 series contains noise and performance data for the Airbus 330, Boeing 737-700, the Cessna Citation 550 Bravo and several Cessna piston engine aircraft.

We anticipate that the FAA will release **Version 6.0c** before the end of 2001; this version will contain new noise and performance data for the entire fleet of Gulfstream business jets.

Appendix A of these notes contains a chart that describes major differences between Versions.

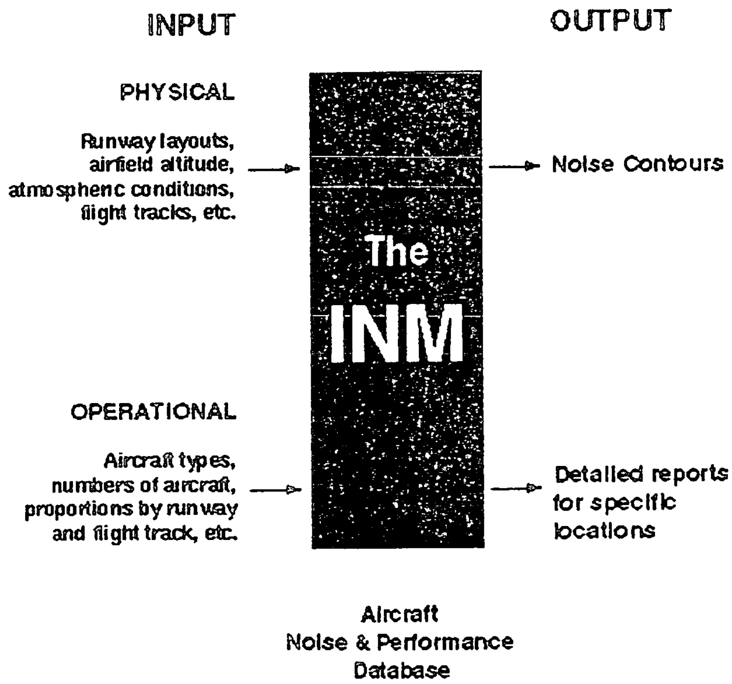
We recommend that you check the FAA's web page regularly, as the FAA does not typically announce interim releases, such as 6.0b The FAA's web address is: http://www.aee.faa.gov.

The INM Black Box

It is possible to think of the INM as a "black box", which produces contours or detailed noise level reports as its output. The model requires input in two principal categories: physical and operational.

The INM contains, within its black box, standard noise and performance data for most commercial aircraft types and standard noise data for most military aircraft types. An airport database is also included with some physical data (runway end coordinates and field elevations) for some airports.

The inside of the black box also contains sophisticated calculation algorithms that take the input data and standard database information to create the output. It is a good idea for INM users to have an understanding of what happens inside the box, so that output may be judged for reasonableness.

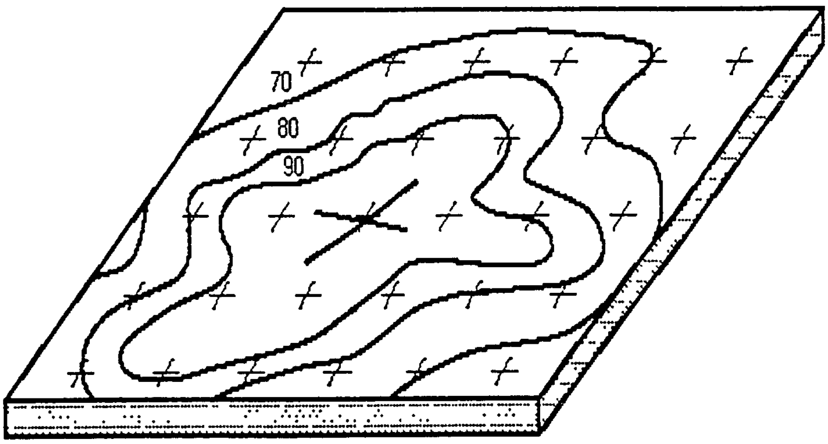


How Does the Black Box Work?

To create noise contours, the INM computes noise levels at finite points on a grid, using the physical and operational parameters you specify and the noise and performance data for each flight. The noise levels for all of the flights are then summed (as in exercise 1) to produce the noise level for the requested metric.

A simplistic grid is shown below. After computing noise levels at these points, the INM will produce contours and/or noise level reports, again, depending on the parameters you specify for your output setup.

The next session describes in detail how to enter data and parameters into the INM. The remainder of this session focuses on the types of data required, and how the INM synthesizes this information.



Physical Input Data Requirements

You can think of the physical input data requirements of the INM as the geometrical features that will determine the shape of your contours. Specifically, these include:

- runway layout,
- flight tracks,
- airport elevation, and
- average airport weather conditions.

Related elements include:

- runway usage rates, and
- flight track usage rates.

A good source for some of the physical data requirements of the INM is the current Airport Layout Plan (ALP).

The best sources for runway use and flight track data are permanent noise monitoring systems and radar tracking systems. If you do not have access to these types of data, spend some time in the field or FAA Tower observing flight tracks. Tower personnel also can provide good estimates of runway use and flight track use. However, be aware that you may get subjective responses to questions that normally are not asked of Tower personnel.

Operational Input Data Requirements

Total Operations

The operational input data can be thought of as the airport's fleet mix. The INM requires information on the number of arrivals and departures (by stage length) for all significant types in the fleet mix.

The first step in determining your fleet mix is to compute total operations. Depending on the airport, this can be done a number of ways, including using Tower counts, flight schedules, OAG data or noise monitoring system data.

If your goal is to compute contours depicting DNL (or other 24-hour metrics), you usually will collect a years' worth of data, and from that, calculate the activity on an average day

NOTE: You may use the INM for other modeling needs, such as computing DNL for a specific day or season. You also can compute single event contours and noise levels. These course notes are focused on the goal of creating annual contours, but the procedures are essentially the same for other uses as well.

Aircraft Type

INM version 6.0 contains more than 200 aircraft types in its database, version 5.0 contained 108. Appendix C contains a list of the INM 6.0 database, including a brief description of the airframe and power plant (engine type).

You will notice that there are a number of INM aircraft codes available for some aircraft types. For example, the database contains two different types for modeling the 737-300: with either the CFM 56-3B-1 engines or the CFM56-3B-2 engines. Since this detailed engine information normally is not included with flight schedules, you often will need to obtain airline fleet data to determine the fleet composition. We suggest using resources such as *JP Fleets International*. In some cases you will need to make judgments on which INM or substitution aircraft to choose based on what you know about its noise and flight performance characteristics.

FAR Part 36 Stage Certification

The INM database includes information on aircraft Part 36 certification levels: Stage 1, Stage 2, and Stage 3 ICAO noise categories are similar to these The Stage certification information in the database has no bearing on the noise calculations, but are listed to assist the user in choosing INM aircraft types.

Appendix E contains a table of the 111 standard data base aircraft with profile data, their Part 36 stage certifications (if applicable) and calculated SEL values at a series of points for noisiness comparisons This table can also provide assistance in choosing INM aircraft types.

The INM database includes some Stage 1 and 2 aircraft. FAR Part 91 precludes commercial Stage 1 and 2 aircraft that weigh over 75,000 pounds from operating in the U.S If you unintentionally select one of these aircraft types, you can significantly overestimate noise levels.

Aircraft Type Substitutions

It is possible that you will need to model aircraft that do not appear in the database. You have two options:

- Define your own aircraft type: This is a complicated endeavor, covered in Section 4: Advanced Features. We do not recommend it unless you have a compelling reason.
- Use an FAA pre-approved substitution: the INM contains the pre-approved substitution list in its database. It is recreated in tabular form in Appendix D for your reference.

An example of a pre-approved substitution is the following:

INM Aircraft Type	Substitute for the following
LEAR35	Bae (Hawker-Siddely) 125-800
	IAI 1124 Westwind
	Jetstar 1 Turbofan
	Lockheed Jetstar 2
	Learjet 31
	Learjet 36
	Learjet 55
	Falcon 10
	Falcon 200
	Sabreliner 65

WARNING!

If the FAA will be reviewing your contours, you must use FAA approved substitutions. If you are unsure about making a substitution, contact the FAA (see User's Guide, page A-1). Appendix B of the User's Guide is a checklist outlining the procedure for getting FAA approval on user-defined INM noise and performance inputs.

Day-Night Split

In order to compute DNL, CNEL, or other time-corrected noise metrics properly, you must identify operations separately according to the time period in which they occur (i.e., day, evening, and night). Since nighttime operations are assessed a 10 dB penalty in the computation of DNL and CNEL (equivalent to ten times as many operations), it is important to have as accurate an estimate of nighttime activity as possible.

For example, if there are 10 operations by a certain aircraft type during a 24-hour period, and you estimate that only one of those operations is at night, the "effective" number of total operations is 19 (9 daytime plus 10*1 nighttime) If, on the other hand, the actual number of nighttime operations is 2, or even 1.5, the effective number of operations changes to 28 or 23.5, resulting in changes of 1.7 or 0.9 dB, respectively, in your DNL computation.

You can calculate the "effective" number of operations under other metrics as well. For example, a 4.77 dB penalty (for evening operations in CNEL) is equivalent to three times as many operations (10 * log (3) = 4.77)

Stage Length

For departure operations, you also must identify the stage length. Simply put, stage length is the trip distance. Stage length is important because longer flights typically carry more fuel (weight), which affects aircraft performance. Page 8-19 of the User's Guide describes stage length in more detail

The table below defines the stage lengths for the INM:

Stage length	Trip Distance
1	0 to 500 nmi
2	500 to 1000 nmi
3	1000 to 1500 nmi
4	1500 to 2500 nmi
5	2500 to 3500 nmi
6	3500 to 4500 nmi
7	more than 4500 nmi

Since only the largest aircraft in the INM database are capable of flying the longer trip distances, only those aircraft have profiles defined for the longer trip distances. The smallest aircraft in the database have only one departure profile, that for stage length 1 the term stage length applies only to departures. In the INM, there may be up to seven standard departure profiles; these usually correspond to the seven stage lengths listed above There may also be more than one arrival profile, although these are numbered, they bear no relation to trip distance or aircraft weight.

WARNING!

Warning: At many airports, trip length may not correlate with aircraft weight. For example, if the price of fuel is high at a destination airport, the airlines may 'tanker' more fuel than is required to make the trip, driving up the weight relative to the INM's stage length assumptions. Also note that airlines with short turn around schedules may tanker fuel to avoid time spent re-fueling

Exercise 2: Develop a Fleet Mix from Flight Schedules

The Workbook contains all the data you need to determine the fleet mix for New York City Airport, and partially filled-in operations data tables for you to complete.

Step ❶ On pages W-5 and W-6, fill in the day/night, stage length, and daily operations columns for each airline. The USAir table has been completed for you. Refer to the map on page W-9 to estimate stage length distances.

Step ❷ Calculate the average daily operations for general aviation aircraft from the data given at the bottom of page W-6

Step ❸ Fill in the equipment, stage length, and average daily ops columns of the operations summary worksheets on page W-11 by summing the day and night operations for each aircraft type/stage length for each airline.

Step ❹ Determine the aircraft type INM Code:

- First, refer to the INM database list (Appendix C) to see if the aircraft is one of the standard INM aircraft.
- In some cases, you will need to investigate the airline's equipment list (as given on pages W-7 and W-8) to determine which model(s) of the aircraft type *best matches* the carrier's fleet.
- For some aircraft, you will need to use INM substitutions. Refer to the substitution list (Appendix D) to see if the aircraft is included there.
- Occasionally, a certain aircraft with a particular engine may not be listed explicitly in either the standard aircraft or substitutions databases. Then, you will need to make judgments based on relative noisiness. (Appendix E contains a reference table.)

Step ❺ Specify the aircraft category using the following arbitrary codes: commercial passenger flights will be COM, charter will be CHT, cargo will be CGO and general aviation will be GA

Noise and Performance Data

The INM contains a database of 226 aircraft (Version 6 0). For 111 of these aircraft, (100 civilian and 11 military types) the database contains aircraft performance profiles, and noise level vs. distance curves

For the other 115 aircraft, only noise level vs. distance curves are provided; the user must develop performance profiles in order to use these aircraft in a study. These aircraft are all military types adapted from the NOISEMAP program.

This section introduces the concepts of performance profiles and noise curves, and their relationship to one another. Session 4 will provide more detail on how to input these data for non-standard aircraft.

Aircraft Performance: Takeoff Profiles

Aircraft performance profiles for departures consist of three components relating distance to actual performance characteristics. These include:

- Altitude (Climb or Descent) profiles that depict the altitude of the aircraft (in feet, relative to the airport elevation) as a function of track distance (i.e , distance from start of takeoff roll);
- Power level (Thrust) profiles that depict the aircraft engine thrust (in pounds or percent of maximum) as a function of track distance; and
- Speed profiles that depict the aircraft's speed (in knots) as a function of track distance.

The database includes a complete departure profile set for each stage length identified for the aircraft type, and a complete arrival profile set. For some aircraft, the profile data is in absolute terms in relation to the distance flown along a flight path. For most of the standard aircraft for which profile data is available, however, the data is given as a set of parameters that the INM uses together with other physical data to generate a specialized set of profiles. The two types of profile data entry are described in detail in Session 4.

The figures on the following pages depict Altitude, Thrust and Speed profiles for the A300 (A300 B4-200 with CF6 50-C-2 engines), stage length 1 (0 to 500 nmi) departure. These graphs were generated by INM with the profile graph feature.

WARNING!

INM-plotted profile graphs often have different scales.

Aircraft Performance: Approach Profiles

Arrival performance profiles are similar to departure profiles, with the following differences:

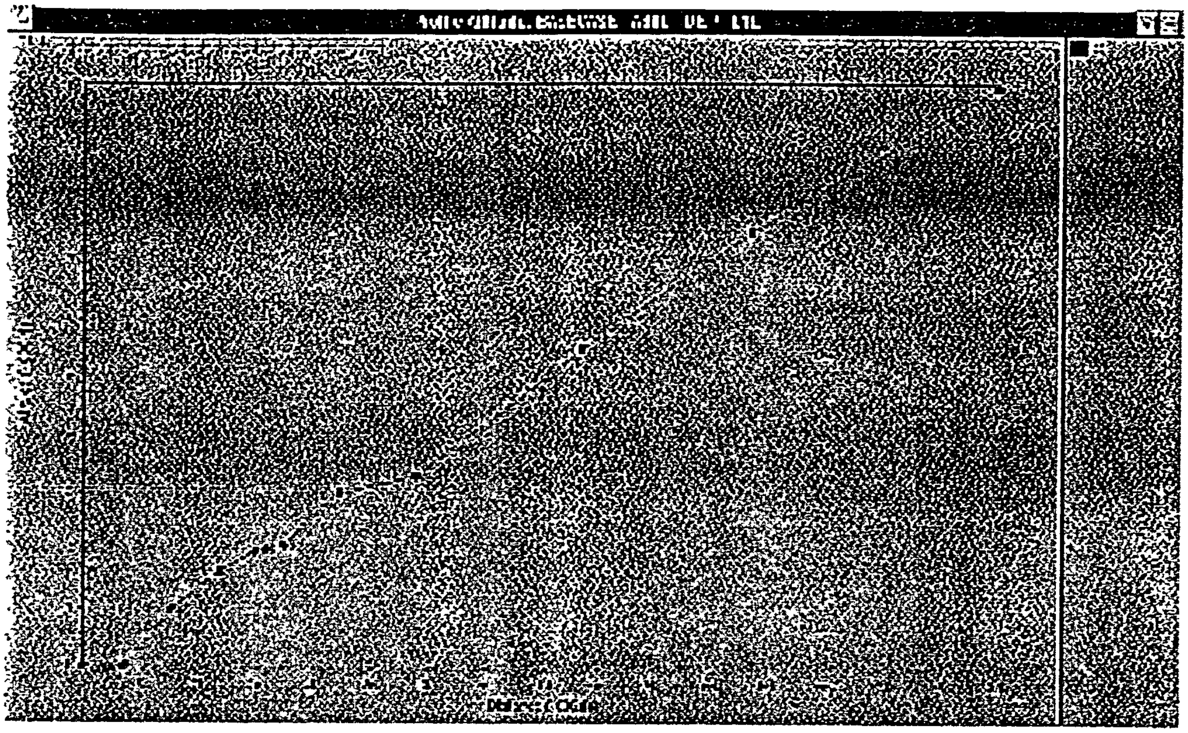
- Arrivals are modeled as they are flown, that is, from "level flight" descending to the ground, making all profiles the reverse order of departure profiles

- Arrivals typically are modeled with a 3% or 5% glide slope (approach angle). Therefore, the altitude profiles for different aircraft types on approach are essentially the same.

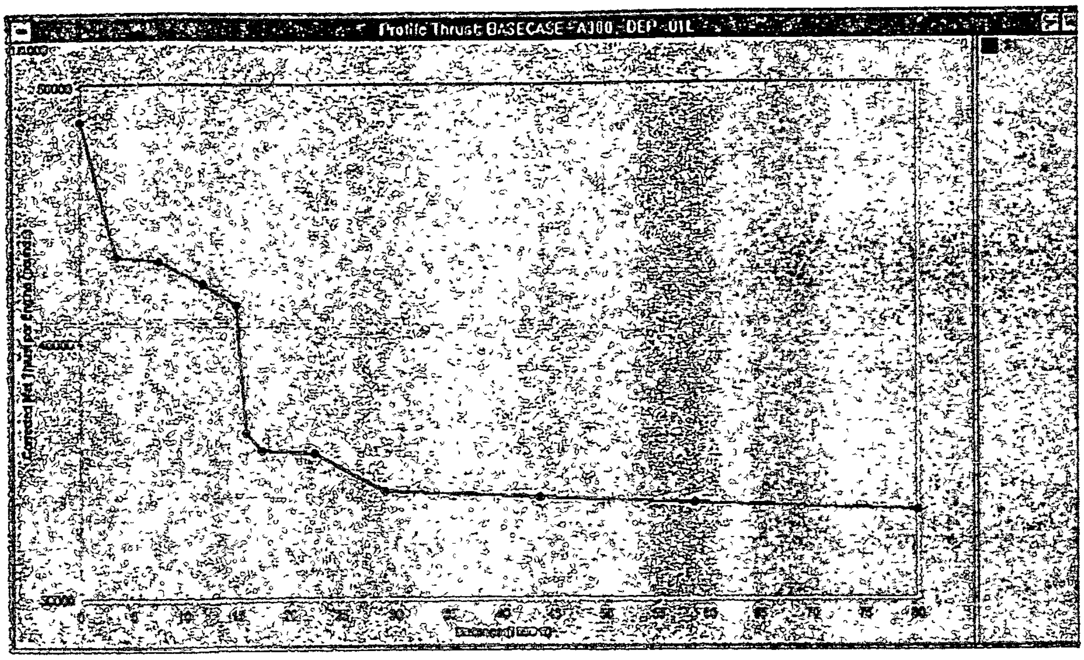
- "Stage length" is not applicable to arrival operations since the INM assumes aircraft weight does not vary at landing as it does at takeoff.

To model non-standard approaches (such as a precision approach with a hold down), you can modify the approach altitude profile. However, if you do so, make sure to modify thrust and speed profiles as well.

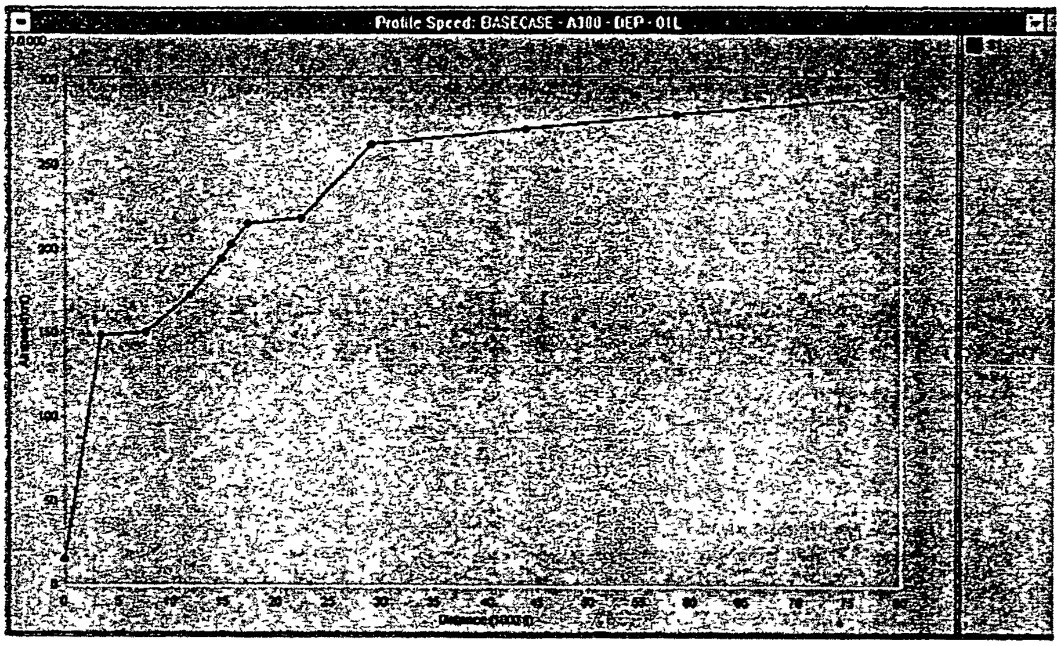
Aircraft Performance Takeoff Altitude Profile



Aircraft Performance: Takeoff Thrust Profile



Aircraft Performance: Takeoff Speed Profile



Noise Curves

The INM contains noise level vs distance curves - referred to in the INM User's Guide as noise-power-distance (NPD) data - for each aircraft type in the database Noise levels are provided for the following metrics

- Sound Exposure Level (SEL)
- Estimated Perceived Noise Level (EPNL)
- Maximum A-weighted level (LAMAX), and
- Maximum Perceived Tone-Corrected Level (PNLTM).

[See Session 1 for a review of these metrics.]

The database does not contain noise level data for all four of the above-listed metrics for all aircraft types; however, it does contain SEL and EPNL data for all aircraft types. For those cases where LAMAX and/or PNLTM data do not exist but are required for certain calculations, the INM uses SEL or EPNL data to derive the LAMAX or PNLTM. Page 17 of the INM Technical Manual presents the derivation equations. Also note that the database does not contain any C-weighted data. These data are created by the INM from the A-weighted data and the spectral data. We discuss this data creation in Session four.

INM 6 has at least two noise curves (of each type) for each aircraft type, representing different engine thrust levels. NPD curves are defined as either "takeoff" or "approach" curves. NPD "curves" are defined by a series of discrete noise levels at given slant distances, for a given thrust setting. The INM interpolates or extrapolates (linearly) to determine noise levels at other thrust settings. The figure on the following page depicts typical SEL curves for the A300.

The distances shown in the noise curves represent the slant distance (slant range), not the track distance (distance from brake release). Be aware that the User's Guide and dialog boxes do not distinguish between these two distance terms.

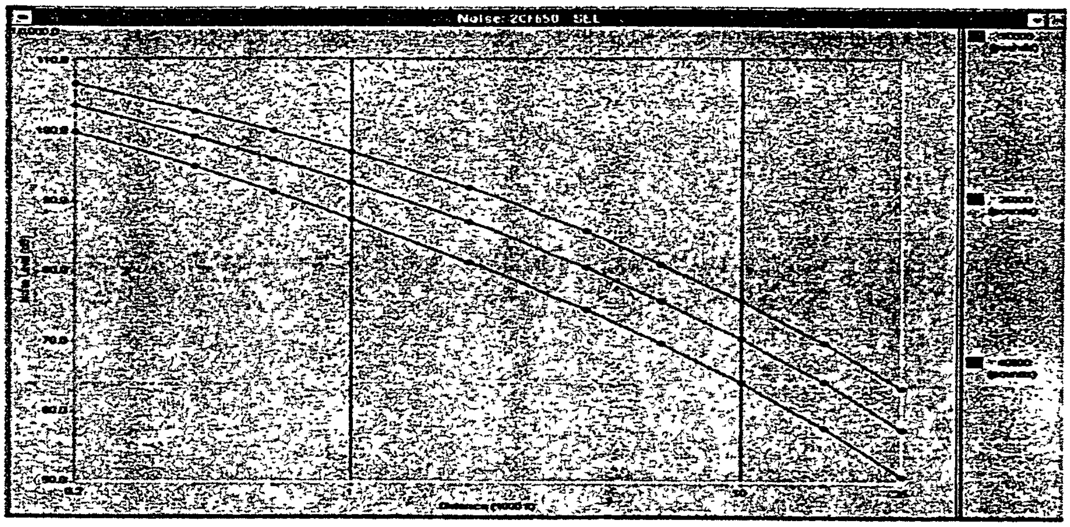
WARNING!

The spectral class for each aircraft type is also defined under this menu option. INM 6 contain 76 spectral classes: 34 approach classes and 31 departure classes. These classes contain aircraft types with similar spectral shape

This graph depicts the noise curves for the A300 aircraft, which are supplied for three different thrust values. The top curve is for a thrust of 40,000 pounds, the middle for 25,000, and the bottom for 10,000 pounds of thrust. At other thrust levels, the INM interpolates or extrapolates from these three curves.

WARNING!

INM 6 limits this extrapolation to a maximum of 5 dB above the highest noise curve and -5 dB below the lowest noise curves.


Noise: 2CF650 SEL

Integration of Profiles

To understand how the various profiles are related in the computation of noise levels, it is useful to look at an example.

The figure on the following page is a simplified* demonstration of how the INM uses the database to determine the SEL from an over flight at any given computation point. The process can be described by this series of steps.

❶ Determine the point of closest approach (POCA) of the aircraft's flight track to the point on the ground.

❷ Estimate the track distance from the start of takeoff roll to the POCA.

❸ Use track distance to determine speed, altitude and thrust from the profile graphs.

❹ Estimate the perpendicular distance from X to the POCA and use it and the altitude to determine slant distance.

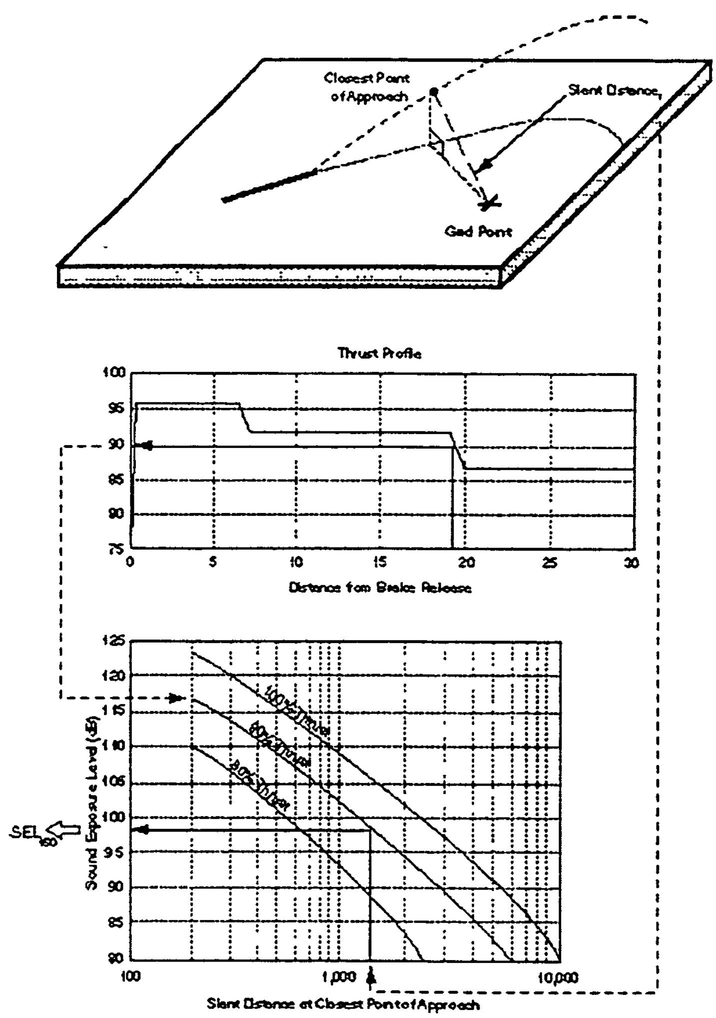
❺ Use slant distance and thrust level to determine SEL at 160 knots (SEL_{160}) from the noise curve graph.

❻ Use the speed at the POCA to determine the necessary adjustment to SEL.

The INM calculates the SEL (or EPNL) from each flight operation and sums them (as described in session 1, in the discussion of Day/Night Average Sound Level) to get the DNL (or CNEL, NEF, etc.) at a grid point. It does this for hundreds or thousands of individual grid points in order to draw DNL (or CNEL, NEF, etc.) contours.

* The INM also makes adjustments for Acoustic Impedance, Noise Fraction, and Lateral Attenuation (and, for ground-roll noise, Directivity) In our example, where the aircraft is well airborne, the flight track is uncomplicated, and the grid point is relatively close to the ground track, these adjustments are negligible (assuming standard meteorological conditions) Chapter 3 of the INM Technical Manual explains these adjustments in detail

Integration of Profiles



Exercise 3: Compute SEL at a Specific Location

Using the data supplied in the Workbook, compute the SEL at grid location "X".

1. Determine the point of closest approach (POCA). To do this, draw a line perpendicular to the flight track from point "X". The length of this line is your "perpendicular distance".
2. Estimate the track distance from the start of takeoff roll at the POCA.
3. Determine the speed, altitude and thrust at the POCA from the speed, altitude and thrust profiles: Find the track distance on the horizontal axis of each graph and read the parameter value from the vertical axis.
4. Estimate the slant distance from the altitude (a) and the "perpendicular distance" (b). *Note: the perpendicular distance and the altitude form two sides of a right triangle - the length of the third side (slant distance) can be found using the relationship* $a^2 + b^2 = c^2$.
5. Determine the SEL (at 160 knots) at the slant distance, using the noise curve graph: Find the slant distance on the horizontal axis; determine which thrust curve to use (or sketch in an interpolated curve, if necessary), then read the SEL_{160} off the vertical axis.
6. Determine the correct speed adjustment factor. (Adjustment = 10 x log(160/speed at POCA))
7. Make the SEL adjustment. (True SEL = SEL_{160} + adjustment)

❶ Perpendicular Distance	4000
❷ Track Distance	8000
❸ Altitude at POCA	1076
❸ Speed at POCA	
❸ Thrust at POCA	
❹ Slant Distance	4142
❺ SEL_{160}	
❼ true SEL	

Contour Computation Parameters

When the INM computes contours, it uses a recursive grid subdivision algorithm to determine the points at which noise will be computed This process is described below and in detail in the INM Technical Manual, chapter 4

Noise levels are computed for points in the contour grid in a series of steps called refinements. Consider the four corners of the contour window to represent refinement level zero. Then, a new point is placed between each pair of existing points (horizontally, vertically, and diagonally) creating a 3-by-3 grid. INM creates an initial grid with a 1 nautical mile grid spacing. The user controls the grid spacing with the refinement number, as follows:

Refinement Level	Grid spacing (feet)
3*	6076
4	3038
5	1519
6	760
7	380
8	190
9	95

* Initial 17 x 17 grid with 1 nmi spacing

The user specifies the number of refinements to be performed; 4 is the minimum value, 18 is the maximum. For example, if refinement level is set to 4, the INM performs one subdivision of the 17-by-17 grid, if it set to 8, the INM performs 5 subdivisions of the initial grid.

At each refinement level, 9-point sub grids are tested against the user-set tolerance value The center point of each straight line of three points is tested to see if it differs from the average value of the two end points by more than the tolerance. If it does, then each quarter of the sub grid adjacent to the differing point is subdivided by inserting five new points in that smaller rectangle (one in the center and one along each side).

The figure below shows an example 9-point sub grid.

48.4		48.1		49 0	
					x indicates locations where new points will be added in next refinement
50 3	x	49 7	x	50 7	
x	x	x	x	x	
53.0	x	51 8	x	53 3	

As the refinement process continues, new points are added only in areas where more detail is needed to determine the placement of the contour line. This results in an irregular grid.

You must set the refinement, tolerance, and cutoff parameters before running the contours. Also, you must define the locations of the four corners of the contour window.

Page 10-6 of the User's Guide provides a short description of the grid control parameters.

In general, contour accuracy increases with higher refinement and lower tolerance parameters. However, run times also increase with precision, sometimes dramatically and unnecessarily.

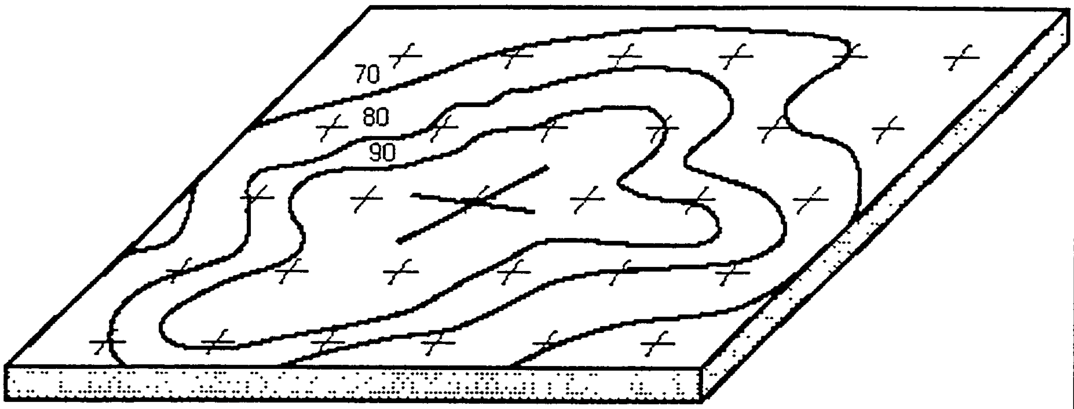
Do not assume that your contours are accurate to within 1 dB because your tolerance is set to 1 dB. The tolerance is essentially the limit of precision, not the minimum precision.


WARNING!

Studies that were created in a previous version of INM may have used a non-standard grid (default 16 nmi x 16 nmi). INM 6 will set up the contour grid using the default, which may lead to different results.

Exercise 4: The Contour-Drawing Process

You will receive a sample INM grid, with calculated noise levels indicated at each point. Attempt to draw noise contours in by hand by connecting points of equal value Remember· contour lines cannot cross each other. It may be best to start near the runway locations and work outwards.



Some of you will have received identical grids. After contours are drawn, form a group with the others who had the same grid and compare your results. Each group should attempt to arrive at a "compromise" set of contours. Each group should then compare their contours to the INM-generated contours for that grid.

Topic for Group Discussion: Why are the contours from the identical grids different? Could computer-generated contours for identical grids come out different?

All of the grids were calculated using the same input data but different calculation parameters, resulting in different coarseness of grid point placement. The different groups should compare their contours.

Topic for Group Discussion: What are the effects of the different calculation?

Session 3. Developing an INM 6 Study

Session Goals:

To understand the basic processes necessary to use the INM for noise analyses, including:

- intent of data collection and refinement procedures;
- efficiency and organization of data entry tasks;

  and

- management of model capabilities to satisfy analysis needs

Data Entry

Order of Entry

The INM User's Guide (page 2-10) lists four different ways to input data into the INM:

① Enter data interactively in various form-input windows

② Enter track data graphically in the Input Graphics window

③ Import data from specifically formatted text files (e.g., .dxf)

④ Use a database management or spreadsheet program to create DBF files directly

This course focuses primarily on the first method of data entry – the use of the program's pull-down menus and dialog boxes. Chapters 3 through 12 of the User's Guide give a detailed description of every menu and sub-menu item in the program in the order they appear, from left to right, and top to bottom, in the program windows.

WARNING!

These notes are ordered with a building-block approach instead; with "foundation" data described first, followed by other data elements in a logical progression. Although the order of data entry described here does not have to be strictly followed, there are some items that *must* be entered before others, due to the database file structures (since some database records *own* others). We recommend that data be entered in the order described here for best results.

In this session, we will step through the basics of building an INM study from scratch. As each new topic is presented, you will have the opportunity to practice with the computer.

Hints

- The organization of data is based on a Study and Cases principle. Understand which data belongs at each level before starting The shaded boxes in this session list the data elements; each is marked with **S** or **C** to indicate that it is study-level or case-level data.

- The input format is similar, in order of entry and detail required, to previous (ASCII text) versions of the INM. It is generally best to work through menus from left to right, top to bottom (with some exceptions)

- Collect data (as completely as possible) ahead of time in 4 categories:

    1. Airport physical characteristics

    2. Flight Track Geometry

    3. Operations data (usually for an average 24 hour period)

    4. Runway and Flight Track usage

- Simplify input data to minimize run time without compromising accuracy. Too much detail really slows things down, but oversimplification can give misleading results.

- For many items (e.g., runway headwind data), if you do not know the information for the airport of interest, use the INM defaults.

Data Requirements

The required data for an INM study/case are, in four categories:

Airport Physical Characteristics	**S** ☞ Airport Name **S** ☞ Airfield Elevation **S** ☞ Coordinate System Origin **C** ☞ Average Meteorological Conditions (temperature, pressure & headwind) **S** ☞ Runway Names **S** ☞ Runway Endpoints (in latitude and Longitude coordinates)
Flight Track Geometry	**S** ☞ Sketches or radar data depicting aircraft flight paths for all type of operations
Operations Data	**S** ☞ List of specific aircraft types using airport **S** ☞ Noise and performance data for any non-standard aircraft types **C** ☞ Number of (average day) airport operations broken down by: →daytime and nighttime periods (or day, evening, night) ⇒operation type (i.e. arrival, departure, or touch&go) and stage length of departures ⇒specific aircraft type
Runway & Flight Track Usage	For each aircraft type (or category of specific types): **C** ☞ runway usage percents AND flight track usage percents by runway end or **C** ☞ flight track usage percents (over all of the model tracks)

The **S** and **C** indicates study- or case-level data

Airport Physical Characteristics

Information required:
- S ☞ Airport Name
- S ☞ Airfield Elevation
- S ☞ Coordinate System Origin
- C ☞ Average Meteorological Conditions (temperature, pressure, & headwind)
- S ☞ Runway Names
- S ☞ Runway Endpoint Locations & Elevations (in latitude and longitude coordinates)

Use the **Setup** menus in the program - see Chapter 6 of User's Guide - to enter general airport information. The airport name, field elevation, and coordinate system origin is entered under **Setup//Study** (as the information will not change from case to case of a study). If the **View Airports** feature is used in the **Setup//Study** dialog box, runway coordinates may be automatically entered as well. The User's Guide cautions that these runway data *should not be assumed to be correct.*

WARNING!

Choose the coordinate system origin wisely at the start of the data entry process. and DO NOT change it later on. (Other data entered later may have coordinates referenced to the origin that *will not* be adjusted to reflect changes to the origin position.)

If you want to model two airports in the same study, they must both be defined in the same coordinate system. Also, the study elevation will be taken from the first airport defined.

WARNING!

Average meteorological conditions are entered for each case under **Setup//Cases.** The profile generator algorithms use these data. The profile generator also uses the airfield elevation parameter and runway gradient information (which it calculates from the runway endpoint elevations).

Use the **Track** menus in the program - see Chapter 7 of User's Guide - to enter runway information (or to check and/or edit runway data that was automatically entered from the **View Airports** feature). Enter runway names under **Tracks//Runways** first, and then enter specific runway end data under Tracks//Runway Ends.

Runway ends must be specified in X, Y coordinates in INM version 6. A calculator utility for translating from nautical miles to lat-long is provided under **View//Lat/Long Calc.** Page 5-3 of the User's Guide describes how to do the translations in INM 6.

HINT

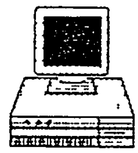
Since runway names cannot be duplicated, try to anticipate whether "additional" runways will need to be defined to represent changes such as runway extensions in different cases of your study, so that you can choose a logical naming convention. The runway names you use have no bearing on the calculations, they are for your own reference.

It is *very important* to input runway end coordinates correctly, because the geometry of the whole study depends upon them.

WARNING!

Check the displaced threshold parameters carefully so that the start-of-takeoff-roll and approach thresholds are where you intend them to be in relation to the runway end. You can use a "delta distance" later, when specifying flight track geometry, if you want the thresholds moved only for certain operations. (See the diagram on page 7-25 of the User's Guide for an illustration on how displaced thresholds and delta distances are interpreted by the INM.) Note that the glide slope parameter in the **Tracks//Runway Ends** window is not used in the noise calculations.

Exercise 5: Airport Physical Characteristics



Step ❶ To start, begin a new study with **File//New Study**; define the new study in the path c:\INMCOURS, using the new study name NEWYORK.SDY. Choose English units.

Use **Setup//Study** to enter the following information

Description:	New York City Airport, NY
Origin of coordinates	
Latitude:	40.777243
Longitude:	–73.872609
Elevation:	336.8 feet, MSL

Step ❷ The Workbook contains an Airport Layout Plan (ALP) for New York City Airport (page W-20). Runway names and runway endpoint coordinates can be read off the ALP, as can runway end elevations and any displaced thresholds. Enter the runway end names and coordinates using the **Tracks/Runway Identifiers**, and **Tracks/Runway Ends** menu items. Assume no changes from the default values for glide slope or threshold crossing height. Use **Tracks/Input Graphics** to verify that the coordinates are reasonable.

Step ❸ Using **Setup//Case**, create a "Basecase" using these weather data:

Temperature:	64° F
Pressure:	30.0 Hg
Headwind:	8 kts
Humidity (%):	70%

Select **Modify NPD curves.**

Flight Track Geometry

Information required:

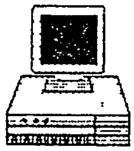
- Sketches or radar data depicting aircraft flight paths for all types of operations

There are two different types of flight tracks used by the INM: points-type tracks and vectors-type tracks. We will call both of these "model tracks" since they are meant to be representative of *all* the actual paths aircraft may use. The program can display radar tracks if they are available in the proper format, but it cannot use those tracks for noise calculation. The radar track function is only meant to be used for guidance in creating the model tracks; you can't directly enter radar tracks into the INM.

Model tracks may be entered graphically, using the **Tracks//Input Graphics** window (points-type tracks only), or numerically, using the **Tracks//Track Identifiers** and **Tracks//Track Segments** windows (vector-type tracks only). See Chapter 7 of the User's Guide for descriptions of both of these methods. "Subtracks", which represent dispersion around a "backbone" track, can be created for points-type tracks. These function as a unit with the backbone track in both track naming and in assigning aircraft operations.

Since most airport noise studies include a fairly large number of model flight tracks, the best method for data entry may not be through the menus and dialog boxes that require the user to type in data by hand. However, for simple cases, this method is the most direct. The input graphics window will allow you to bring in a CAD file containing an ALP or map of the area, which may be helpful for sketching tracks. Advanced users may prefer to enter track data directly into the TRACK and TRK_SEGS database (.DBF) files, using other software packages. You should experiment with the different methods of flight track data entry to come up with your own preferred methods.

Exercise 6: Flight Track Geometry



The flight track map in the Workbook shows the routes of typical arrival and departure traffic on Runway 04/22. Arrival tracks are labeled with "A" and departure tracks are labeled with "D". Page W-23 describes the flight track geometry in vectors.

Step ❶ Input this track geometry using the Vectors-type data entry method. **Remember:** tracks must be entered as they are flown, that is, departure flight tracks start at the takeoff runway end, and arrival flight tracks end at the arrival runway end.

Note: to avoid over-writing your tracks as you create them, be sure to use the ✚ button before starting each track and watch the left side of the dialog box to make sure it fills up with the track names.

Step ❷ View the entered tracks with the **Tracks/Input Graphics** window.

To avoid abrupt endings to flight tracks (and noise computations), make the last segment of departure flight tracks and the first segment of arrival flight tracks long (e.g., 50 nmi).

Operations Data

Information required:

- S ☞ List of specific aircraft types using airport
- S ☞ Noise and performance data for any non-standard aircraft types
- C ☞ Number of (average day) airport operations broken down by:
  - → daytime and nighttime period (or day, evening, night)
  - → operation type (i.e., arrival, departure, or touch & go) and stage length of departure
  - → specific aircraft type

Use the **Setup** menu in the program – see Chapter 6 of User's Guide – to enter types of aircraft that will be used in the study. These may be chosen from the list of standard INM aircraft types and/or the list of pre-approved substitutions (which assign a standard INM aircraft type to a much larger list of specific aircraft). It is not always clear what the aircraft in the lists are just from the six-character codes, but longer descriptions can be found within the program under the **Acft** menu, or in the User's Guide Appendix F. Printed lists of the Standard Aircraft database and substitution list are also included as reference in the appendices of these notes.

There are INM aircraft types in the standard database that are Stage 1 and 2 (under FAR Part 36 certification) over 75,000 lb, even though these older, noisier aircraft are not allowed to operate at U.S. airports. Be sure you know which aircraft you are choosing. The Noise Stage indicator in the **Acft//Aircraft** dialog box is there to help with INM type identification (and has no bearing on noise calculations).

Use the **Acft** menu in the program – see Chapter 8 of the User's Guide – to manually assign aircraft substitution, to manually create a new aircraft type, or to edit noise and performance data of a standard aircraft type. Session 4 - Advanced Features covers the methods of customized aircraft data entry.

The **Acft//Aircraft** dialog box entries should be left unchanged if only the standard INM types and pre-approved substitutions are to be used in the study. The program automatically brings up this window after the list of aircraft is chosen in the setup menu. Although it is useful for providing information about the chosen standard aircraft, it is usually not necessary to change any parameters, (except perhaps the user-defined group, for flight track assignment purposes) and the window should just be closed.

WARNING!

In versions 5.1 and later, any of the data displayed in the **Acft//Aircraft** dialog box can easily be edited, where in INM version 5.0, it could not be changed without first creating a new aircraft identifier. We strongly recommend that you DO NOT change any of the standard aircraft data except the user-defined group without changing the name of the aircraft, so that you will remember that changes occurred.

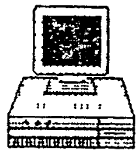
Use the **Ops** menu in the program - see Chapter 9 of the User's Guide - to enter the numbers of aircraft operations. These may be entered either as total airport numbers for each aircraft type (**Ops//Airport Ops**), or broken down further as the number of operations on each flight track by each aircraft type (**Ops//Flight Ops**).

If the total airport method is used, percentage data for flight track assignment must also be entered (as described in the next section). In most cases, this method of data entry is much more efficient, as far fewer entries need to be made. It is also possible to use a combination of the two methods.

WARNING!

A drawback to the **Airport Ops, Group Percents** method is the inability to specify different percentages by time of day. The major drawback to the **Flight Ops** method is the volume of data required, and therefore the tedium of data entry or data modification through the use of dialog boxes.

Exercise 7: Operations Data



Step ❶ We will use the same operations data we evaluated in Exercise 2 as the operations tempo for this exercise. A completed table is given in the Workbook, on page W-25. First, the list of study aircraft must be entered under the **Setup//Aircraft** menu. NOTE: Upon completing data entry in Setup//Aircraft or **Setup//Substitutions**, the **Acft//Aircraft** or **Acft//Substitution** windows are opened automatically.

Step ❷ Pay attention to the "user-defined group" given for each aircraft in the **Acft//Aircraft** window, and change them if necessary to the aircraft category codes listed in the operations table. You will need to use the group identifiers to assign flight track usage by percent (after you finish entering operations numbers).

Step ❸ Enter the day/evening/night operations numbers for each aircraft type/stage length in the **Ops//Airport Operations** window.

Note: Use the Add Record button (+) to avoid overwriting other entries. The left side of the dialog box will keep a list of the entered data for each set.

Runway and Flight Track Usage

Information required:

For each aircraft type (or category or specific types):

- runway usage percents AND flight track usage percents by runway end

or

- flight track usage percents (over all of the model tracks)

If you enter operations data using **Airport Ops**, then you will use the **Ops//Group Percents** function to enter the percent usage rates that will be applied to the data entered in the **Ops//Airport Ops** dialog box. The "groups" are defined in the **Acft//Aircraft** window, as noted in the previous section. If you use the **Ops//Flight Ops** method instead, you need to pre-calculate the operations on each track.

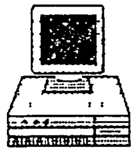
It is usually easier in the data collection process to focus on the group of flight tracks on each runway end separately, creating a runway usage table and tables of track usage. If the usage data are collected separately, you will need to calculate the flight track usage percents over all of the model tracks, since that is how the data must be entered into the INM.

WARNING!

The **Ops//Group Percents** option does not allow you to enter different usage rates for different time periods. Thus, if your nighttime usage is different from daytime, you must use the **Ops//Flight Ops** option (or enter data directly into the ops_flt.dbf file).

To review the operations data before running the noise calculations, use **Ops//View Ops.** This feature displays the operations data in summarized or filtered forms, as well as complete listings. Creating a data filter is relatively easy; an explanation is provided on page 9-10 of the User's Guide. It is often useful to check totals of modeled operations. Use the **View Summary** button in the **Ops//View Ops** window to do this. The resulting display is explained on pages 9-11 and 9-12 of the User's Guide. The grand totals are given at the bottom of the listing.

Exercise 8: Runway and Flight Track Usage



Step ❶ The flight track usage tables for New York City Airport (in the Workbook, pages W-27 and W-28) have been partially filled out for you, referring to the track names on the given track map. On these tables, add the track names for the tracks you created for Runways 13/31. Note that the track usage is given in terms of whole-airport percentages by aircraft category. Open the **Tracks//Input Graphics** window again to view the set of tracks you previously entered, and make sure that all of the tracks listed in the table have been defined. Use the **View** menu to choose which tracks and features are displayed.

Notice that no different usage rates are given for time of day in this exercise. Thus, you should assume that daytime and nighttime usage rates are the same. In real situations however, usage is often different at night than during the day because of wind conditions or traffic flow. Since the INM currently is not capable of computing operations-by-percent at that level of detail, another data entry method would have to be used for those situations.

Step ❷ Enter the track percentages (in the eight tables on pages W-27 and W-28) by using the **Ops//Group Percents** window. Each entry is a separate record. For each aircraft group and operation (departure or arrival), step through the list of runways and tracks. Note that the profile group will always be S (for Standard) since we are only using standard profile data.

Step ❸ When the data entry is completed, use the **Ops//View Calculated Flights** to see a listing of the data. Always press the **Compute New** button after making any edits to your data, so you will see the effects of the changes. To see if the total operations match your intended total, choose **View Summary** and scroll to the bottom of the list. The "&" symbol acts as a "wild card" in this display, so the line beginning:

&&&&&& D & & &&& &&&& &

displays operations for <u>all</u> aircraft Departures using <u>any</u> profiles on <u>all</u> runways and <u>all</u> tracks.

☺ Once the data are correct, it is time to run the contours.

Noise Calculations

Grid Setup

To perform noise computations, you must specify the desired grid parameters in the **Run//Grid Setup** window. A "grid" can be as simple as a single point (a 1 x 1 grid) or as complex as the recursively subdivided grid used for contouring. INM recognizes three types of grids: contour, standard and detailed.

For a contour grid, specify only the outer limits of a rectangle; the INM will determine the location of all other points based on its recursive subdivision algorithm (and parameters entered under **Run//Run Options**.) To specify the rectangle's limits, first enter the X, Y coordinates of the lower left-hand corner and then indicate the height and width of the rectangle

HINT

If the airport coordinate system origin (specified under **Study//Setup**) is in the center of the airport, the defaults for contour grid specification are usually adequate. If you don't need contours, just leave the defaults in place, and make sure the **Do Contours** option is shut off under **Run//Run Options.**

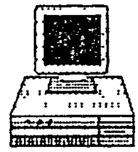
Standard and Detailed grids are used for specific point computations (see the discussion in Session 4). The difference between these two types of grids is the level of detail given in the output report. The grids are defined as rectangles, in the same way the contour grid is defined, but with the further options of specifying the interior grid points and of rotating the rectangle away from the X, Y axes.

WARNING!

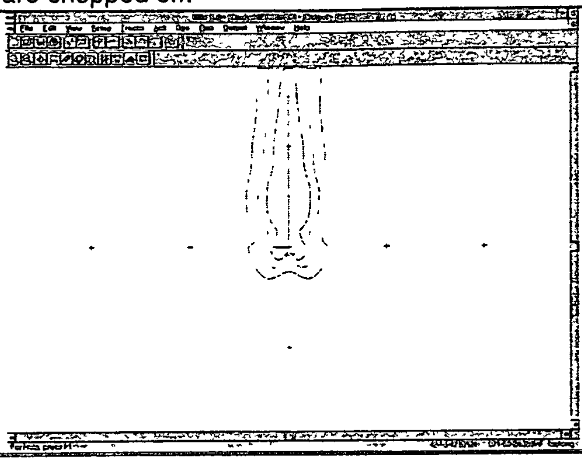
In previous versions of the INM, noise at specific points could only be calculated by requesting a grid calculation. With INM5 and later versions, specific point computations can also be done using sets of *location points* or *population points*. However, even if these calculations are all that is desired from the INM run, you must enter something in the **Grid Setup** menu. Session 4 will provide more information on specific point calculations.

Changing the grid setup can significantly change your contours (even for the same input). It is important when comparing cases that you make sure the grid options are the same

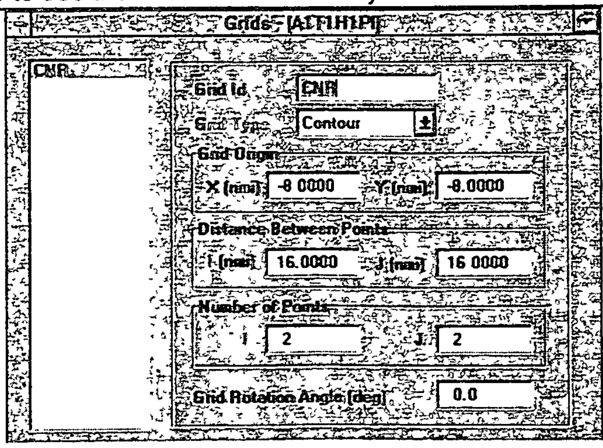
Exercise 9: Choosing Contour Grid Parameters



Scenario - You have successfully finished all your data entry and have calculated contours. However, it appears that your contour grid setup (you used the defaults) weren't quite right because your contours are chopped off:



This is the grid setup window with the default parameters. Make corrections to the parameters so that you will be able to see the entire contour after you run the calculations again.



Refinement   Low Cutoff   Display
Tolerance   High Cutoff   Display

Running the Model

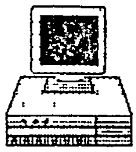
Use the **Run//Run Options** window to turn on (or off) the respective options for computing contours, specific grid points, and other specific points (entered as population and location points). There is also a switch labeled **Do Terrain** (which would be more accurately labeled as "Use Terrain Data"), this refers to terrain elevation files, which must be purchased separately and processed by the INM prior to use.

Use the Single Metric option unless you need to create more than one set of contours from a single case (using two or more different metrics from the same metric family). The only advantage to the MultiMetric run is the reduction in computation time from a series of Single Metric runs. Specific point calculations cannot be made in MultiMetric mode. The MultiMetric mode also cannot be used to calculate Time Above contours for different thresholds simultaneously.

If you request contours, you should review the contouring parameters of refinement, tolerance and cutoff values. See Session 2 (page 2-22 and 2-23) for a discussion of these topics. See also the User's Guide, page 10-6. The INM defaults are 6 for refinement and 1 dB for tolerance. These values are a good starting point if you are unsure what to use. Run times increase with higher refinement (and, to a lesser degree, with lower tolerance).

To begin computations, open the **Run//Run Start** window, and choose the cases you want to run. Some runs take a very long time — a typical complex case can take several hours or overnight to complete. Using Windows NT or Windows 95/98, you may be able to use other applications while the INM runs, but doing so will slow down the run, since the computer has to share its resources. Run times for the same case can vary greatly, depending on the available memory and computing speed of your computer, and the tolerance and refinement settings.

Exercise 10: Running the Model



Step ❶ In preparation for running contours, set up the contour grid. Since our airport origin is near where the center of the contours is likely to be, the default contour grid parameters should work well.

Step ❷ Under the **Run Options** window, choose **Single Metric** and **DNL**. Make sure the **Do Contours** box is marked, and set the refinement, tolerance, maximum and minimum levels. Since we have not entered any specific point data, and since we are not requesting Time Above contours, all the other features of this window can be ignored.

Step ❸ Start the run. When it finishes, open the **Output** menu. Before you can view the contours, you must setup an output directory with **Output//Setup**. Make sure to specify **DNL** again, and choose max and min levels within the range you specified in the **Run Options.** Your output type will be **OneCase.**

☺ Now you can view the contours with the **Output Graphics** window. If you have extra time, experiment with the different contour display options and colors.

Looking at Model Output

After a case has finished running, the results are obtained through the Output menu – see Chapter 11 of the User's Guide.

If contours were computed you can see them in the **Output Graphics** window, but first you must use the **Output//Output Setup** dialog box to make post-processing specifications. In this setup process another study subdirectory is created which is at the same level as the case subdirectories Thus, you must choose an Output ID name that is different from the Case name, although you will want the output name to indicate which case run(s) created it.

The reason that the output subdirectory cannot be contained *within* a case directory is that the INM has the capability to compare, add, or merge the contour grids from different cases. Therefore, the output files are not necessarily "owned" by a particular case. Pages 11-3 and 11-4 of the User's Guide offer some ideas on naming conventions to help organize cases and outputs. It is helpful to use a 3-character extension to differentiate among cases and output with the same root name.

The INM uses a contouring program called NMPlot in the process of creating the display shown in the graphics window. You can access NMPlot outside of the INM interface, as well If necessary, contours that will not work with the output graphics feature can sometimes be salvaged and manipulated by using NMPlot directly

INM Study and Case Management

Directory Structures

The INM produces a number of files in which it stores input and output data for each study. In addition, the INM program stores its own data base information and auxiliary programs in a number of different files under several subdirectories. See Appendix D of the User's Guide for a list of the various system directories and files contained in each. Output and Case specific data are stored in study subdirectories. See Appendix E of the User's Guide for a description of each type of .dbf file. Some of these files contain study level data, some contain case level data: they are stored in corresponding directories as they are created. Some of the files are created automatically but are empty until needed.

As noted in the User's Guide, it is best (especially for new users) to allow INM to manage the study directories, and to add, copy, or delete cases or records through the INM menus (as opposed to using Windows or DOS).

To avoid destroying or misplacing files accidentally:

- DO NOT change subdirectory or file names

- Place study directories OUTSIDE the INM program directories, perhaps in project directories. The INM will probably be installed on your PC hard disk, but other disks (including network disks) may be used for study directories.

- Always start an INM session by OPENing an existing or new study with the File menu, and remember to CLOSE the study when ending the session. When the INM is started up, it is in the state as the last user left it, which often means a study will be open already. Users who are unaware of this can very easily alter that study's data inadvertently, and, since records are saved as they are created, it may be impossible to restore the study to its previous state.

Alternative Cases from Base Case

Often, a baseline case for a noise study is created first, with one or more alternative cases to follow To use an existing case as a template for a new case:

- Go to the **Setup//Case Copy** window The new case will be defined automatically, using the same weather data as the case being copied

When using Case Copy, all case data will be duplicated, and then you can make changes to data records as necessary in the new case. If two cases are vastly different, it may be more efficient to simply create a new case from scratch, and use the Cut, Copy and Paste functions to duplicate individual records.

WARNING!

Note that you can add to or change study-level data at any time. If you find it is necessary to do so when creating a new case, be aware of how that might affect the previous cases. For example, you might create a base case with a 6000-foot runway. If you then need to evaluate the effect of a 1000-foot runway extension, you should define a new runway with a different name, and change the necessary flight track and operations records to reflect the new runway name. If you redefine the runway end coordinates instead, your base case is then altered.

HINT

Whenever possible, the range of alternative cases should be considered when the base case is created, to setup the study-level data as completely as possible. Occasionally, two cases may require different data at the study level, which may make it impossible to run them as two cases of the same study In such a situation, the entire study directory can be copied to a new study directory (using Windows or DOS commands) and the changes could be made without affecting prior work

Session 4. Advanced Features

Session Goals:

- To gain a general understanding of the range of INM Version 6 capabilities

and

- To briefly examine some of the more complex model features

Database File Manipulations Outside of INM

Often, the amount of data required to accurately represent an airport's operations is too cumbersome to enter by hand through the dialog boxes For example, the set of flight tracks at a busy airport may number well over a hundred, even in a simplified case, and each of the tracks may consist of several segment records. To enter each record individually would be tedious.

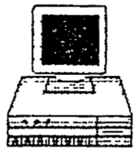
Many experienced users of previous versions of the INM have devised their own methods of data management to deal with such problems. The INM employs the database file format to allow users to bypass the dialog box data entry method. A user can create database (.DBF) files directly, which can replace those generated by the dialog box process, provided the format is correct. Database files consist of "records" and "fields". A field is the name of the column describing the type of data. A record is a row entry in the file, with one piece of data in each field.

The User's Guide contains printed examples of each of the INM standard database files in Appendix F.

WARNING!

If you need to edit a database file that will be used by the INM, use a data base management system (such as Microsoft Access or FoxPro) rather than a spreadsheet (such as Excel or Lotus). If the column widths get changed, (which can happen automatically by importing the file into some spreadsheet programs) the INM will no longer be able to read the file. With current versions of Excel and Quattro Pro, you can save your work as a DBF file, and the program will allow you to manually set the column widths so that INM can correctly read the file.

Exercise 11: Database File Manipulations Outside of INM



In this exercise, we will create an operational alternative using Microsoft Excel spreadsheets to update operations information. The new case will reflect the transition of hushkit aircraft to "pure" Stage 3 aircraft (i.e., aircraft with high-bypass ratio engines).

Step ❶ Using the study you created in Session 3, create a new case using **Setup/Case Copy**. Select **basecase** as the case to copy from and enter a new case name: **stage3**. This command will create a new case directory, with duplicate copies of the "basecase" case .dbf files.

Step ❷ Find the file named ops_arpt in the case directory (which was just created under Step 1 above). Double-clicking on the file will launch Microsoft Excel, with the data base file.

Step ❸ Edit the data base file in Excel, making the following changes:

Change ~~737215~~ to 737500
737N?
Change DC9Q9 to B717 (substitution type 717)

Change727EM2 to 757PW

Save the file, making sure that the column widths of the data fields are unchanged from the required data base structure. See Appendix E, page E-8 of the User's Guide.

Step ❹ Include the new aircraft types have been into your study using **Setup//Aircraft** and **Setup//Substitutions**. Do not delete the aircraft types that have been replaced (in case you may want to re-run the basecase contours at some future date).

Step ❺ Run the new case.

Using Custom Noise & Performance Data

If you wish to change any data for a standard INM aircraft type, you should use a different aircraft identifier. In INM 6 it is possible to change data for a standard aircraft type in your study without changing the aircraft identifier, but we strongly recommend that you do not do so, since it will be very difficult to know later for which aircraft data were changed.

Noise Curves

A noise curve (for a specified thrust) consists of a list of noise values for a series of distances. Noise curves are individual records in a noise table. The INM uses four different types of noise tables. A-weighted metrics are defined in terms of SEL or LAMAX (or both). Perceived, tone-corrected metrics are defined in terms of EPNL or PNLTM (or both). C-weighted curves are derived from the A-weighted curves and the spectral data for the particular aircraft.

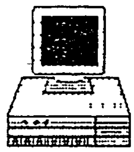
You must supply noise vs. distance data for user-defined aircraft, or specify one of data base noise curves. A set of noise vs. distance data must contain at least one of the four possible types of noise tables, and at least two curves (two thrusts) for both departure and arrival (four total) so that the INM can interpolate/extrapolate.

The INM aircraft database contains the necessary data for all the standard aircraft, and these records can be copied for use with user-defined aircraft, if appropriate. Typically, a single noise table in the database is associated with several standard aircraft. Noise curves can be completely user-defined as well. The User's Guide gives guidelines for noise curve definition. Because of the relationship between LAMAX and SEL and between EPNL and PNLTM, you only have to define one curve of a pair and INM will derive the other. You can review user-defined noise curves with the **Acft//Noise Graph** window.

Do not confuse the "distance" values in the noise tables with the "distance" values in the performance profiles. In the noise tables, the term distance refers to the aircraft's distance from a listener, and is often called its "slant distance". In the performance profiles, the term distance refers to the aircraft's distance along the flight track from the start-of-takeoff or touchdown point.

WARNING!

Exercise 12: User-Defined Aircraft and Noise Curves



In this exercise, we will create a new aircraft type to represent the Falcon 900, a three-engine corporate jet. This aircraft type does not exist in the INM data base, and FAA recommends using the LEAR35 aircraft, plus 1.8 dB (to account for the extra engine).

Step ❶ Create a new aircraft type by copying LEAR35 to the clipboard. Then click on the paste icon, and copy the LEAR35 as FAL90.

Step ❷ Using the new FAL90 record, change the Description (to something you will later recognize, such as "Falcon 900"). *Notice that all of the other parameters (Max Gross Takeoff weight, Max Gross Landing Weight, etc) were all copied from the LEAR35 record. Since this new aircraft is essentially the same as the LEAR35 (but noisier) we will leave all this data in place and change only the noise curve.*

Step ❸ The FAA instruction for modeling the Falcon 900 is to use the noise curve for the LEAR35 plus 1.8 dB. The LEAR35 uses noise curve TF7312. Create a new noise curve by opening the **Acft//Noise Identifiers** window and click the ✚ button to add a new record. Give a 6-character name to the new noise curve that you will later recognize as belonging to the FAL90. Make sure that the thrust setting type is pounds, and that the noise model type is INM. Choose the same spectral classes as for the TF7312 noise curve.

Step ❹ In the **Acft//Noise Curves** window, pull up the data for the TF7312 curve, select all the SEL records in the left-hand box, and copy them to the clipboard. Then find your new noise curve name and paste in the data. Now, for each SEL record, go through and add 1.8 dB from every noise level. *Note: Appendix G of the User's Guide lists the Noise Curve name associated with each INM aircraft type. You can also see which curve an aircraft uses by looking in the **Acft//Aircraft** window*

Step ❺ Back in the **Acft//Aircraft** window, change the noise curve name by choosing the curve you just created. You are now finished defining your own aircraft type!

Performance Profiles

Aircraft performance profiles have three components: thrust levels, speeds, and altitudes. There are two methods for performance profile input to the INM _ they are called **Fixed Point Profiles** ("profile points") or **Procedural Profiles** ("procedure steps"). The User's Guide (pages 8_21 to 8_38) covers both of these methods in detail.

The difference between the two kinds of profile input is that profile points data are linked to particular track distances while procedure steps are not. With procedure steps, the INM's profile generator uses the flight procedure information, together with the field elevation and meteorological conditions data, to produce specific profiles. Most of the standard civilian aircraft in the INM database have performance profiles defined in terms of procedure steps.

Thirteen of the INM standard aircraft have data defined by profile points. These include five Stage 1 aircraft (the 707, 707120, 720, 727200, and DC820), the 747100, SABR80, F16A, F16GE, F16PW0 and the F16PW9 aircraft. For the MD11GE and MD11PW aircraft, the approaches are defined with profile points, the departures with procedure steps.

Profile graphs can be generated for either kind of profile input. These are useful for finding out how different meteorological conditions affect the aircraft performance profiles, or to evaluate the effects of noise abatement departure procedures (such as those specified by AC 91-53A). The **Acft//Profile Graphs** window allows you to see the resulting profiles.

Profile Points

In **Profile Points**, thrust, speed and altitude data are specified at points along the ground track. For departures, the points are identified by distance (in feet) from the start-of-takeoff-roll. For arrivals, the points are identified by distance from the touchdown point. Note that for arrivals, the distances are specified as negative numbers; the more negative the number, the farther the aircraft is from the runway.

Profile Points data are not affected by the airport elevation and atmospheric conditions inputs. Aircraft are not capable of the same levels of performance at high-elevation airports as at airports close to sea level, due to the performance-degrading effects of decreased air density. Thus, using **profile points** data, which were developed for sea level conditions, will result in under-predicted noise levels at high-elevation airports. However, profile points data entry is more straightforward in terms of user control over INM interpretation.

Procedure Steps

Procedure Steps, aircraft performance is defined by a series of steps which each have their own set of parameters Unlike in the profile point's method, the program calculates the track distance; it is not a user input In procedure steps, the user determines what happens, the computer calculates where it happens. The rules for profile building are described in detail in the User's Guide, pages 8-28 to 8-32.

The required parameters in the Procedure Steps window vary according to the Step Type. There are nine possible step types, described in the User's Guide, pages 8-23 to 8-27.

They are:

- Takeoff, Climb, and Accelerate - for departure profiles;
- Descend, Land and Decelerate - for approach profiles;
- Level and LevelStretch - used. in addition to the above step types, for touch-and-go and circuit flight profiles. and
- CruiseClimb - for lower-thrust climbing

Procedure steps are based on the algorithms defined in the Society of Automotive Engineers' Aerospace Information Report AIR-1845. The algorithms are all based on physical equations defining the motion of the aircraft as a mass responding to the forces which act upon it: lift, drag, weight and thrust. The weight of the aircraft is integral to the INM database. Lift and drag are determined through selection of **Flaps ID** settings, and thrust is determined through choice of a **Thrust Type.**

The INM has five thrust types available. The first two, **MaxTakeOff** and **MaxClimb**, are used in the standard departure profiles **MaxTakeOff** and **MaxClimb** thrusts are calculated from engine coefficients used in the **Jet Thrust** or **Prop Thrust** windows. These coefficients are used to calculate the thrust based on aircraft speed, altitude and air temperature. The other three thrust types, **ReduceThrust**, **UserCutback**, and **UserValue**, are used in building user-defined profiles.

Noise Abatement Departure Procedures

Advisory Circular AC 91-53A defines recommended Noise Abatement Departure Procedures (NADPs). The AC lists two NADPs: a close-in procedure and a distance procedure. The close-in procedure is intended to provide noise reduction for residences close to the airport, while the distance procedure is intended to provide noise reduction for residences more distant from the airport. The procedures differ primarily in their flap retraction schedules. The close-in procedure recommends thrust reduction at not less than 800 ft Above Field Elevation (AFE), followed by climbing with takeoff flaps to 3000 ft. The distance procedure recommends beginning flap retraction at 800 ft AFE, then reducing thrust while climbing to 3000 ft AFE. The upper limit for either procedure's thrust reduction is define as "climb thrust", the lower limit is the thrust required to maintain the climb gradient defined in FAR 25.111(c)(3).

In practice, airlines use a variety of thrusts for their NADPs. These thrust settings are often defined in terms of Engine Pressure Ratio (EPR) or engine rotational speed (N1), rather than pounds of thrust. The INM does not provide a conversion from these engine parameters to engine thrust.

ReduceThrust is used when building noise abatement departure profiles (e.g., AC 91-53A or ICAO). The thrust in this case is computed by the INM as the minimum thrust which satisfies the requirements of FAR 25 111(c)(3), which defines aircraft one-engine-out climb performance. **UserCutback** allows you to enter a specific engine thrust for an entire segment. **UserValue** applies the thrust you select to the final point of the current segment; INM calculates the thrust for this segment as changing continually from the final thrust of the previous segment to the **UserValue** thrust.

The INM User's Guide, page 8-29, gives guidance on how to define NADPs using procedure steps.

Modeling Runups and Touch-and-Gos

Runups

Including runup operations in your input is relatively simple (see pages 9-13 and 9-14 of the User's Guide.)

In the **Ops//Runup Ops** window, specify the aircraft type, runup pad coordinates (relative to airport origin), aircraft heading (in degrees from true north), engine thrust, duration of runup, and numbers of runup operations for each time period.

WARNING!

Note that the directivity algorithm incorporated in the INM is generalized for all aircraft types. Therefore, for any given aircraft type, the noise contour from an individual runup operation is not likely to match measured noise levels taken at different positions around the aircraft. This is especially true for propeller aircraft and military aircraft, since the INM's directivity algorithm is based on jet aircraft noise measurements. Page 9-14 of the User's Guide provides the equations for the directivity pattern, which is used in the INM.

Remember that the noise curve in the INM represents all of the engines on an aircraft. Many times a runup will only involve one engine. In these cases, you will need to adjust the thrust setting to account for this, using the formula on Page 9-14 of the User Guide.

Touch-and-Goes (pattern operations)

All closed-pattern operations (including those which come to a full stop on the runway), are referred to in the INM as Touch-and-Go operations. However, there are two types of operations in INM used to model closed patterns:

- a TGO (touch-and-go) operation starts on the level-flight (downwind) segment of the pattern, lands without stopping, takes off, and ends on the level-flight segment,
- a CIR (circuit flight) operation begins from a full stop on the runway, takes off, and flies the pattern, lands, and stops.

By using a combination of these two types of operations, the INM user can model the noise resulting from the actual behavior of the aircraft as it performs a series of patterns in a row. Of course, in reality, the takeoff from a full stop is followed by (possibly several) non-stop revolutions, and then a landing to a full stop.

In INM there are generic predefined TGO and CIR performance profiles for all aircraft in the INM databases that have performance coefficients. These are provided as **procedure steps** profiles. In addition, the User's Guide describes how to build TGO and CIR profiles using **procedure steps** on pages 8-29 to 8-31, or by using **profile points**, on pages 8-36 to 8-37

Both the TGO and CIR operations use the same flight tracks, which are identified as TGO tracks Pages 7-5 and 7-31 of the User's Guide contain information on defining touch-and-go flight tracks.

Specific Point Analyses

For Comparison with Measurements

Noise measurements are often taken at a limited number of points around an airport, either on a temporary basis with portable monitors or continuously with permanently installed monitors. Comparison of the measured noise levels with INM-calculated levels is usually of interest, and can be used in some cases for contour validation.

Method 1: The coordinates of the measurement locations can be entered as standard (or detailed) grids in terms of X, Y coordinates (in nautical miles referenced to the airport origin) under the **Run//Grid Setup** window.

Method 2: Alternatively, the points may be entered as location points in latitude/longitude under the **Setup** menu. (See the User's Guide, page 6-14 and 6-15.)

Look at the results through the **Output//Standard Grids** window, of the **Output//Noise at LocPoints** window.

The advantage to using the grid method over the location points method is that the results are reported in greater detail for a standard grid than for a location point. Even more detail is provided if the points are entered as detailed grids, but that level of detail is not usually necessary for measurement comparisons.

The INM will calculate noise at standard grid points only if the box **Do Standard Grids** is marked with an x under the **Run//Run Options** window. The metrics checked off in the grid box will be the metrics that get calculated in addition to the metric indicated in the main **Noise Metric** space to the left (See the User's Guide pp. 10-9).

For Population Impact Assessment

The Census feature is under **File//Import.** This feature is designed to read US Census data files and extract centroid point data for processing by the INM (The data must be purchased on CD-ROM from the Census Bureau) The data are extracted into a binary file and a database file. See pages 3-14 to 3-15 of the User's Guide for a description of the necessary files and processing procedure.

Each "population point" represents the centroid of a census block. The INM calculates the noise level at each point and counts the entire block population as inside a contour line if the noise at the centroid is greater than the contour value

The INM outputs the data in three formats:

- Population points can be graphically displayed as a layer in the **Output Graphics** window. The binary file is used for this display.
- Total population and area within a contour are given. View the results through the **Output//Contour Area and Pop** window The pop_pts data base file is used for the calculation.
- Noise level data (for a chosen metric) are calculated for each individual centroid. The results are accessed by the **Output//Noise at Pop Points** window, as described in the User's Guide, page 11-21. The pop_pts data base file is used for the calculation.

For Diagnostic Use

Occasionally, specific point analyses are done to investigate the contributing factors to the calculated noise levels. For example, if the noise contour results look different from what you expected, you can explore the possible reasons through the use of detailed grid points placed at strategic locations.

The points are entered in terms of X, Y coordinates (in nautical miles referenced to the airport origin) under the **Run//Grid Setup** window. The results are accessed through the **Output//Detailed Grids** window. (See pages 11-18 to 11-20 of the User's Guide.)

For each individual flight record, the contribution to total noise level is calculated. The flight records are ordered in the output table from greatest to least contribution separately by metric. Other pertinent information for the flight are given, such as aircraft type, track name and operation type. The distance from the point on the ground to the aircraft at its closest point of approach (POCA) is provided. Also, the aircraft's altitude, speed, and thrust level at the POCA are listed.

In short, virtually every piece of information that goes into the calculation of noise at the point is listed in the detailed grid report. Therefore, the output is lengthy, but useful for in-depth analyses.

The INM will calculate noise at detailed grid points only if the box **Do Detailed Grids** is marked with an x under the **Run//Run Options** window. The metrics checked off in the grid box will be the metrics that get calculated in addition to the metric indicated in the main **Noise Metric** space to the left. (See the User Guide p. 10-7). Note that the detailed grid files can get very large.

Using INM Terrain Feature

The INM User's Guide, pages 3-11 to 3-13, describes the necessary steps for using the INM's terrain processing feature. The **File//Import Data into Study** feature is used to extract terrain elevation data from a separately purchased compact disk, which will then be stored in the study directory. The INM will access these data and use them during grid point computations if the **Do Terrain** box is checked off in the **Run//Run Options** window.

Enabling the terrain feature affects the calculation of noise in two ways. The first is the use of the actual distance from the aircraft to each ground point (instead of the distance calculated by assuming flat ground at airport elevation). The second is in the calculation of the lateral attenuation adjustment, which uses a terrain-derived ground plane to determine the source-to-receiver elevation angle. The latter of these tends to have the greater effect on calculated noise levels.

WARNING!

The terrain feature is scheduled for improvement in future releases of the INM. Our tests with it have shown some unexpected results, including ragged contour lines, and so we do not currently recommend that it be used.

User-Defined Noise Metrics

The INM has 16 pre-defined noise metrics. For most standard noise studies for U.S. airports, it is not necessary to define additional metrics. However, many of the European countries have developed their own noise metrics, most of which are not among the INM's choices. These or other metrics based on either the A-weighted, C-weighted, or "perceived" noise level may be defined in the **Setup//Metrics** window, and then used for contour or specific point calculations.

Pages 6-6 to 6-9 of the User's Guide describe the equations the INM uses to calculate noise. By allowing the user to specify the parameter constants in the equations, the model is flexible enough to perform noise computations for a wide variety of purposes and specifications. See Session 1 notes for a description of the parameters.

To create a user-defined noise metric, use the **Setup//Metrics** dialog box (as described in the User's Guide, pages 6-6 to 6-9) to choose the one of the three types of decibels ("family") to use as a basis, and one of the three calculation equations ("type"). The choice of type determines how the other parameters in the dialog box, the multipliers and the "10 log (Time)" adjustment factor, are used.

The words "Day", "Evening", and "Night" here do not indicate any particular clock time, but correspond to the labels of the operations entered in the **Ops//Airport Ops** or **Ops//Flight Ops** windows.

Converting Old-Format INM to INM5 Study

Version 6 of the INM does not support a direct conversion from INM 411 (or earlier) files. We recommend using the PREPROC program supplied with version 5.2a of the model to convert to a 5 2a study. Then you will be able to convert the INM 5 2a study to version 6.

Use the **PREPROC//INM411** feature of Version 5 2a to convert a single INM input file as used with INM version 4 11 (or earlier) to an INM5 study (a directory of files). The conversion capability allows previously constructed input data sets to be easily used with the new model. For experienced INM users, the conversion utility may be a preferred method of data input, for some new studies.

Some of the drawbacks to using the conversion utility for creating new studies are described in the User's Guide (Version 5 1), pages 14-2 to 14-5. Because of changes in the modeling approach for run up and touch-and-go operations, these may not convert correctly. Also, carefully check any user-defined aircraft noise and performance data.

Every old-format INM input file is converted to a single-case INM study. Thus, the output capabilities of INM, which allow for subtraction or addition of different cases within a study, cannot be easily used for a set of old-format cases.

Before beginning the conversion with **PREPROC**, decide what directory you want your study to be placed in. It is easiest to let the PREPROC program create the study directory for you by specifying only the drive and path. If you choose a pre-existing non-empty directory instead when the PREPROC program asks for a destination, files may be overwritten and/or the resulting study may be corrupted.

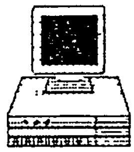
Using Radar Flight Track Data

The INM does not have the capability to process raw ARTS (Airport Radar Terminal System) data directly. To use radar track data, the user must first get the data in the necessary file format. The User's Guide (pages 3-18 to 3-19) describes how a radar text file can be imported into INM.

The INM uses the binary radar track file for display in the input and output graphics windows. The radar tracks can be used as a guide in creating model flight tracks, (as described in the User's Guide, pages 7-9 to 7-11). The INM currently has no radar track sorting or filtering capabilities, and cannot use the radar tracks directly in noise computations.

Raw FAA ARTS data exist in a variety of formats, depending on the type of equipment used to collect the data. Several programs, which read and process the raw data, have been developed individually by various aviation-consulting firms. HMMH has one such program, FLIGHT, and can export the data in INM-readable format. Also, many airport noise and operations monitoring systems will output these files.

Exercise 11: Database File Manipulations Outside of INM



For this exercise, a study has been set up and runway data entered. HMMH processed and sorted ARTS data for Salt Lake City International Airport; a subset of this data has been written to INM format.

Step ❶ Open the study named C:\INMCOURS\SLC

Step ❷ Use the **Track/Input Graphics** window to view the ARTS tracks. If none are visible, use the **View** menu to enable the radar display.

Step ❸ Choose the **Create Track By Radar** icon to begin, then draw a series of gates across a group of radar tracks to define the points of your model track. After each gate a dialog box appears; press **Continue** to go on drawing gates.

- Try a departure first; for arrivals you must start out in space and come towards the airport, which takes some getting used to
- ALL radar tracks crossing a gate are used in the calculations; therefore, if you are doing departures, it is a good idea to disable the arrival display and vice-versa.

Step ❹ When done adding points by drawing gates, press **Add Track.** A dialog box appears in which you must specify your track as an arrival or departure, and give it a name. You may also add dispersal tracks in this box. Make at least one track with and one without dispersion.

- The "Number of Subtracks" means the total of dispersal tracks plus backbone track. Therefore 1 means no dispersal tracks
- The "Track Name" is really the name of the corridor; a digit is added to identify the individual tracks (0 is the backbone, 1&2 are closest to the backbone, with 1 on the left, and so on)

Step ❺ Try using the icon buttons to add, delete & move points within your defined tracks. Try this with a dispersed track set, too. Use the **Idle** icon to get out of an edit mode.

Step ❻ Use the **Disperse Track** icon to view and change the dispersal parameters of your tracks. Try this with a track for which you originally had no dispersal tracks to create some. Also try editing the default parameters for a set of tracks made by using dispersion in step 4, above.

- The "Subtrack Percents" refers to the way operations will eventually be assigned across the group of tracks. You cannot leave the percents at 0 or you will get an error message.

INM Output Manipulations

Graphic Export

The contours, flight tracks and runways can exported from the INM to be used as graphics by other software (such as AUTOCAD or other graphics programs). You do this by converting the results to a DXF (Drawing Exchange Format) file from the Output Graphics window in the INM program.

Open the output graphics window to the case you want. Select File//Export as DXF, and then select the desired units and file destination directory. Page 3-28 in the User's Guide describes the capability.

INM allows the user to export the entire **Output Graphics** window to a .dxf file.

The user can display Tiger street maps in the **Output Graphics** window as follows: export them to dxf, then Import them to a CAD file for use in the **Input Graphics** window.

Data/Text Export

With many of the INM dialog boxes, the File//Export As feature is enabled, allowing the user to extract the all or some of the information accessible under that window to a database (.dbf) or text (.txt) file. This feature is particularly useful in examining the aircraft profiles produced for individual flights by the INM's profile generator. Pages 3-19 to 3-20 of the User's Guide describe the dialog box parameters.

INM Version 6 Enhancements

General Information

Version 6 includes a number of new features and model capabilities. For the sake of our discussion, we have divided them into several categories: changes that may affect output for *existing* cases (i.e., changes to computational algorithms), new features and functions, data base changes, and changes that affect the user interface (i e., have no bearing on the computations).

Computational Changes

Version 6 has several modifications to the computational algorithms in the INM. These include

- Introduction of "spectral classes"
- Division of NPD data into distinct curves for departure and approach
- Changes to the definition of the base grid for contour computations
- Changes to the significance-testing algorithm
- Changes to the terrain computational algorithm

Each of these items is discussed briefly below.

Computational Changes: Spectral Classes

WARNING!

Version 6 includes several modifications and new features that are relevant to the aircraft's frequency spectrum. Because that data is detailed, the FAA has divided the entire database of 222 aircraft into some 72 different "spectral classes" – that is, a collection of aircraft whose frequency spectrum is similar. The spectral class information is described under **Aircraft/Noise Identifiers.** However, even if you are not computing C-weighted metrics (which will directly use the spectral classes), your computations for existing cases may change due to the manner in which propagation is computed using the new spectral class information.

WARNING!

Spectral classes will allow the future inclusion of lateral attenuation based on specific ground type. The Society of Automotive Engineers' Committee on Aircraft Acoustics, A-21, is currently reviewing this feature. It will be added to INM upon approval by A-21. We caution that this lateral attenuation change may have significant changes in the resulting contours, especially in areas currently affected by ground and/or sideline noise (i.e., takeoff roll, reverse thrust).

Computational Changes: NPD Curves

In Version 5, the INM did not identify the mode of operation associated with a given Noise-Power-Distance (NPD) curves (i.e , takeoff or approach). This occasionally resulted in some difficult interpolation and/or extrapolation situations (even errors). Version 6 deals with this issue by assigning a departure or approach code to every NPD curve in the database. This may result in some changes to the output for existing cases (in particular, those with aircraft that had this problem in the past).

In addition, the NPD curves are now limited to a maximum extrapolation of 5 dB beyond the highest power NPD curve and - 5 dB below the lowest NPD curve. This also may change results for existing cases.

Computational Changes: Contour Base Grid

As we discussed in Section 2, INM Version 5 initiated its computations (refinement level 4) as a 17 by 17 grid, based on the initial computation window defined by the user (default is 16 nm by 16 nm, resulting in a default initial grid spacing of approximately one nautical mile). Version 6 starts computations with a variable-size grid, again based on the initial computation window, but starting at one nautical mile grid spacing, *regardless of the size of the computation window* This may affect cases for which you have defined non-standard grid windows.

Computational Changes: Significance-Testing

In Version 5, the computations for a given grid point were limited to the top 97% of flights (operations assigned to flight tracks) at that point. In Version 6, the algorithm has been revised to include the top 97% of flight *segments* affecting a given grid point. This change was made to dramatically decrease the run time of contour computations.

Computational Changes: Terrain Computation

In Version 5, the beta angle has been removed from the computation of terrain effects. The beta angle is the angle between the ground and the aircraft. For example, if the listener is on a piece of ground with a 30-degree slope and an aircraft flies directly overhead, the beta angle is 60 degrees. The beta angle is used in the computation calculation of lateral attenuation. The ground slope was removed from the model because it was causing unrealistic results, particularly in areas with undulating terrain.

New Features

New features include

- C-weighted metrics
- Atmospheric Propagation due to weather
- Variable ambient noise
- New metrics: % Time Above, Number of Events Above
- 100% of Flights in detailed grid analysis
- View/Calculate function for EPR/N1 computation

These are described briefly below.

New Features: C-Weighted Metrics

Version 6 allows the user to conduct analyses using C-weighting. This feature was added primarily to address low frequency noise issues. For example, you can now prepare contours that will depict the maximum C-weighted noise level.

Computational Changes: Weather Effects

Version 6 now considers the annual average relative humidity as well as the temperature at the study airport in its computation of aircraft noise propagation, if invoked by the user under **Setup/Cases**. This enhancement is possible due to the addition of spectral classes, since attenuation is a function of frequency. Previous versions of the INM used temperature only to calculate the effect on aircraft performance; now temperature and relative humidity are both used to compute the attenuation (atmospheric absorption) due to weather. The propagation algorithms used to modify the NPD curves are based on SAE ARP 866A. This may affect your results, depending on the spectral classes of the aircraft in the study, and how different the weather conditions at your airport are as compared with the standard. For most airports, choosing **Modify NPD curves** will result in a 0-1 dB increase in DNL, the longer the distance between source and receiver, the greater the increase.

New Features: Variable Ambient Noise

Version 6 will allow the user to include a file containing the ambient noise levels for a given grid. These levels can be used instead of a fixed threshold for computing Time Above; that is, you can now compute Time Above Ambient.

New Metrics: Percent Time Above and Number of Events Above

These new metrics allow the user to compute:

- **Percent Time Above** [Threshold]: the percent of time (in a 24-hour period) above a given threshold (or, in the case described in the section above, time above ambient).
- **Number of Events Above** [Threshold]: the number of aircraft events (in a 24-hour period), which have noise levels exceeding a given threshold (or ambient level). This metric is not explicitly provided in Version 6, but the user can compute it using **Calculate 100% of Flights** under the detailed grid window.

WARNING!

We caution that these metrics, while perhaps more intuitive than the logarithmic metrics have the same fundamental problems as Time Above (TA): there is no scientific evidence associating any given "dose" with a community "response" (as has been demonstrated for DNL and other exposure-based metrics)

New Features: 100% of Flights in Detailed Grid Analysis

In previous versions, the **Output/Noise at Detailed Grid** report included the top 97% of flights contributing toward the total noise level at a Detailed Grid Location (this was related to the significance testing algorithm) Version 6 will provide 100% of the flight information.

New Features: Thrust Calculator

This new feature will calculate engine thrust levels based on EPR/N1 data provided by the user. This feature, found under **View/Thrust Calculator** is useful for developing User-defined procedures, such as Noise Abatement Departure Procedures.

User Interface Changes

Several features have been added to streamline data entry. Several are described below:

- Aircraft copy: Version 6.0 will support full copy of aircraft data base information. This is useful for defining aircraft.
- NMPLOT: Version 6.0 uses the new Windows-based NMPLOT, which has several effects on graphical display of contours, and also enables the user to use long filenames for the first time.
- Track and profile names: the labels can now be eight characters long.

Session 5. Create Your Own Noise Contours

Session Goals:

- To gain additional familiarity with INM through hands-on practice;

and

- To solidify the concepts learned in the previous sessions through practical application

Calculating Alternative Case Contours from a Base Case

The Scenario:

Your task is to create a ten-year forecast case for New York City Airport, for comparison to current (2000) conditions. Market trends forecasters have prepared a table of predicted average day operations for2010, listed by general aircraft types. This should be changed to reflect that the phase-out has already occured. The airport owner plans to extend Runway 04/22 by 2000 feet to the southwest (Runway 04 end) sometime within the next two years. However, the runway use is not expected to change, since most air carrier activity already uses that runway.

Step ❶ A sample study with base case data has been prepared ahead of time. Open this study (it is named NEWNY). The existing base case represents airport operations for an average day in2000. Begin your alternative case definition by using the **Setup/Case Copy** feature to place all the base case data in a new case called "forecast". Then you can edit that data to form the alternative case.

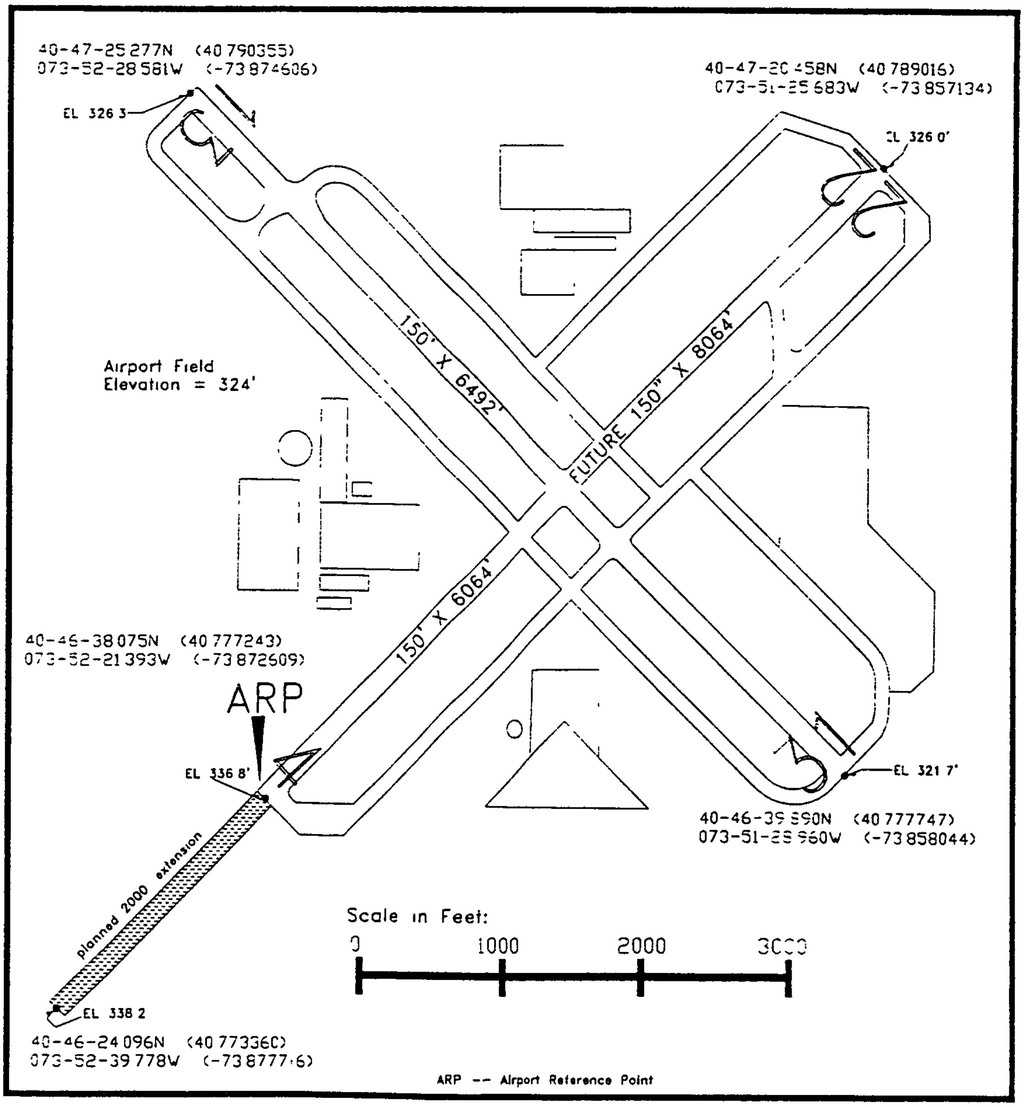
Airport Physical Characteristics:

The only change in airport physical characteristics is the runway extension. Since runway end coordinates are study-level data, you will have to add a "new" runway, rather than changing the pre-defined endpoints. Assume the same weather conditions for the 10-year forecast case as for the base case.

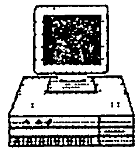
Step ❷ Enter the "new" runway name and endpoints under **Tracks//Runway Identifiers** and **Tracks//Runway Ends**. Refer to the New York City ALP (on the next page), which indicates the location of the planned runway extension.

Calculating Alternative Case Contours (continued)

New York City Forecast ALP



Calculating Alternative Case Contours (continued)



Flight Track Geometry:

Step ❸ You can assume no changes in flight track geometry for the purposes of this exercise. However, you will have to create flight tracks for the new runway end. The easiest way to do this is to copy the track names and track segments from the original runway 04 to the new runway. Use the Edit menu or the toolbar icons to copy and paste flight track and track segment records. *Note: you do not want to delete the tracks from the original runway, since the basecase uses them - remember, flight tracks are study-level data.*

Operations Data:

A forecast operations table is provided on the next page. Notice that all of the large jet aircraft types are Stage 3, since the forecast is for the year 2005.

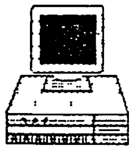
Step ❹ By aircraft type, make the necessary edits to **Ops//Airport Operations.** (Notice that in the basecase, the **Airport Operations** and **Group Percents** features were used exclusively - no operations were entered under **Flight Operations.** We prepared the basecase this way purposely to make the editing easier for the alternative case.)

- You may have to add additional aircraft types in the Setup menu if there are operations by types, which were not included in the basecase. Also, check to make sure that aircraft types used only in the "Existing" case have zero operations in the forecast case. Do not delete unused types from the list, however. (*In fact, deleting aircraft types which are not used in this new case, but which were used in the base case, would cause errors when you next try to view or use the base case.*)

- Note that the MD81 appears in two different aircraft categories: COM and CHT. However, you must specify the "MD81" aircraft as either one group or the other. Thus, you want to create a new aircraft type which is identical to the MD81 except for the user-defined group designator. To do this, **Copy** the MD81 to the clipboard, then hit **Paste**; insert the new name. Make sure that one of these is part of the COM group, and the other is in the CHT group.

Step ❺ Use **Ops//View Calculated Flights** to check the data when you have finished. To view totals, look at the bottom of the list generated by **Ops//View Calculated Flights/View Summary.**

Calculating Alternative Case Contours (continued)



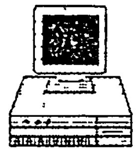
Forecast Operations Table:

New NY Ten-Year Operations Forecast (Average Daily Operations)

Aircraft Category	Aircraft Type	INM type	Arrivals		Stage Length	Departures	
			Day	Night		Day	Night
Air Carrier (COM)	757	757RR	5 00	1.16	2	5 30	0.86
	767-300	767300	1 00		2	1 00	
	767-200	767CF6	1 00		2	1.00	
	MD80	MD81	0 50	0.50	2	1.00	
	737-400	737400	0.71		1	0 71	
	737-300	7373B2	4.00	1.50	1	4.50	1.00
	A320	A320	3 86		3	1 00	
					1	2 86	
	777	777200	6 30	0 24	4	5 87	0 66
Charter (CHT)	MD80	MD81	0 29	0.29	3	0 29	0 29
	Embraer 120	EMB120	0 86		1	0.86	
	Regional Jet	CLREGJ*	2 00		1	2.00	
	Fokker 100	F10065	1 41		1	1.41	
Cargo (CGO)	727-200 (hush-kitted)	727EM2		0 86	2		0.86
	727-100 (hush-kitted)	727QF		0.86	2		0.86
G.A. (GA)	Single Eng.	COMSEP	1.98	0.21	1	1 98	0.21
	Twin Eng.	BEC58P	3 23	0 60	1	3 23	0 60
TOTALS			32 14	6.22		33 01	5.34

* Indicates a substitution aircraft

Calculating Alternative Case Contours (continued)



Runway and Flight Track Usage:

Step ❻ For this exercise, assume no changes to flight track usage. However, since operations will be occurring on the "new" (extended) runway instead of on the original runway, the data in the **Ops//Group Percents** window will have to be edited to reflect that change. Use the **cut** and **paste** features to move these operations. *Note: using **copy** instead of **cut** here will result in operations being modeled from the old runway end.*

Run Options:

Step ❼ Use the same run options, which were used for the basecase to create Single Metric DNL contours. When the case has finished running, setup the **Output** directory. Make sure to specify DNL again, and choose max and min levels within the range you specified in the **Run Options.** Your output type will be **OneCase.**

☺ Congratulations! You made contours!

Step ❽ View the contours in the **Output//Output Graphics** window. Also view the base case contours to see what differences there may be. Do the changes (or lack of changes) make sense? *Note: If you go back and change any of the parameters in the **Output//Setup** window after you look at the **Output Graphics**, make sure to mark the **Repeat Contour Calculation** option so the INM will incorporate your changes.*

Step ❾ Now, experiment with creating difference contours. Do this by setting up another output directory and setting the output type to **Difference**. Here, the contour levels will refer to the *decibel difference*, so your minimum and maximum should be numbers like -10 and 10. How do the difference contours compare with what you expected?

Try This → Go back to the **Run Options** window and turn on the **Do Population Points** option. Rerun the case, and then in the **Output Setup** menu, specify Repeat Contour Calculation. Now you can view the contours with the population points displayed, and check the **Output//Contour Area and Pop** and **Noise at Pop Pts** windows for impact analysis data. Turn Off the **Do Contours** option.

Session 6. Wrap Up

Session Goals:

- To tie up loose ends;
- To collect student opinions of new INM;

and

- To evaluate course effectiveness.

Appendix A in the User's Guide contains a list of contacts on INM-related questions. Also, the sources for terrain, census, and other data are given in that Appendix.

The following pages are for your evaluations of the INM software and of this course. Please fill these out as completely as possible, to help us with future courses. While the course evaluation are used by us to improve the class, we present your thoughts on the model to the FAA at the INM Design Review Group meeting. Thank you

Course Evaluation

Please rate this course by indicating your agreement with the following statements.

Agree Strongly				Disagree Strongly	
1	2	3	4	5	The course was well-organized and easy to follow.
1	2	3	4	5	The course met my expectations.
1	2	3	4	5	I learned enough to use the program on my own.
1	2	3	4	5	I need more formal instruction before I will feel capable of using the program
1	2	3	4	5	The instructors seem very knowledgeable in this field
1	2	3	4	5	The instructors were very helpful.
1	2	3	4	5	I learned things about noise modeling in general, which I didn't know before
1	2	3	4	5	The course notes will be useful to me in my work.
1	2	3	4	5	I enjoyed participating in this course.

Please rate the usefulness of each session separately:

Very Useful				Not at all Useful	
1	2	3	4	5	Session 1: Review of Airport Noise Terminology
1	2	3	4	5	Session 2. Airport Noise Modeling Basics
1	2	3	4	5	Session 3: Developing an INM6 Study
1	2	3	4	5	Session 4. Advanced Features
1	2	3	4	5	Session 5: Create Your Own Noise Contours

Do you think we allocated time well among the sessions?

Too Much				Not Enough	
1	2	3	4	5	Session 1: Review of Airport Noise Terminology
1	2	3	4	5	Session 2: Airport Noise Modeling Basics
1	2	3	4	5	Session 3· Developing an INM6 Study
1	2	3	4	5	Session 4: Advanced Features
1	2	3	4	5	Session 5· Create Your Own Noise Contours

Please tell us what you like about the course.

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Please tell us what you didn't like about the course.

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What could we do to make the course more useful?

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Would you recommend this course to your colleagues? Why or why not?

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Name (optional): ______________________________

May we use your name and comments in future course mailings? ❑ Yes ❑ No
Would you like to remain on our mailing list? ❑ Yes ❑ No

Please indicate your previous experience with noise modeling by checking all that apply:

❑ I have used the INM (any version) before: ❑ A few times ❑ Often ❑ Regularly
❑ I have used other noise models before: ❑ A few times ❑ Often ❑ Regularly
❑ I ❑ prepare ❑ review environmental documents.

Comments / Questions on INM6

Please give us your opinion of INM6, by rating your agreement with the following statements:

Agree Strongly				Disagree Strongly	
1	2	3	4	5	This version of the model is a big improvement over previous versions.
1	2	3	4	5	The User's Guide and Student Guide are helpful
1	2	3	4	5	The program meets my needs as a user.
1	2	3	4	5	It is easy to use the model
1	2	3	4	5	I like the different methods of data entry.
1	2	3	4	5	The format of the program simplifies the modeling process
1	2	3	4	5	I feel confident that the model calculations are correct.

Please rate the usefulness of each of the following specific features of INM6:

Very Useful				Not at all Useful	
1	2	3	4	5	Airport database
1	2	3	4	5	Input Graphics window
1	2	3	4	5	Latitude/longitude coordinate system
1	2	3	4	5	User-defined metrics capability
1	2	3	4	5	Dialog box data entry system
1	2	3	4	5	Radar track capability
1	2	3	4	5	Output Graphics window
1	2	3	4	5	User-defined Noise and Performance Methods
1	2	3	4	5	Other (specify)____________________

Please tell us what you like about the INM, version 6

Please tell us what you don't like about the INM, version 6.

What improvements would you like to see in future INM versions?

What feedback would you like us to forward to the FAA?

Appendix A: Quick Comparison of INM VersionsScrap 4.11 and add 6.0

<table>
<tr><th>INM 5.1/5.2</th><th>INM 5.0</th><th>INM 4.11</th></tr>
<tr><td>Operating System
• Windows NT
• Windows 95</td><td>Operating System
• Windows 3.1, 3.11
• Windows NT 3.51</td><td>Operating System
• DOS</td></tr>
<tr><td>File Structure
• Several database files contain additional information from INM 5.0
• You must convert your INM 5.0 files to 5.1/5 2 files</td><td>File Structure
• Input data in several database files (instead of a single ASCII text file)
• Several output files generated</td><td rowspan="2">File Structure
• One Input file
• One Output file (log file)
• One contour file (Needs to be processed separately by INMPLOT)</td></tr>
<tr><td colspan="2">• INM 5.0 manages the directory structure for your study
• INM 5.0 will process your contours using NMPLOT (v3 04 -- update to v. 3.06 for machines faster than 200 MHz)</td></tr>
<tr><td>Standard Data
Version 5.2:
• 219 Aircraft (Added 2 737 hushkit and 777-200)
• 283 Substitution Aircraft

Version 5.1:
• 216 Aircraft (Added 2 MD90's and Noisemap data)
• 218 Substitution Aircraft</td><td>Standard Data
• 108 Aircraft (Added the UPS 727QF, a modified 727-100)
• 213 Substitution Aircraft</td><td rowspan="2">Standard Data
• 107 Aircraft
• Substitution aircraft on a list, User must enter data</td></tr>
<tr><td colspan="2">• Can add user defined planes to the database for all to use</td></tr>
<tr><td>Airport Database
• Contains Info for over 450 Airports, with improvements in accuracy</td><td>Airport Database
• Contains Info for over 1600 Airports (many without runway end data)</td><td rowspan="2">Airport Database
• Not Available</td></tr>
<tr><td colspan="2">• Database has: Runways, ARP, Elevation, Navaids & Fixes, and Displaced Thresholds</td></tr>
<tr><td colspan="2">Metrics
• 13 pre-defined noise metrics, including a new TA metric algorithm
• User can create own metric and save in the database
• For contour runs, the multi metric mode allows the model to be run once for various metrics from the same family, contours are generated in the post-processing</td><td>Metrics
• 8 pre-defined noise metrics</td></tr>
</table>

INM 5.1/5.2	INM 5.0	INM 4.11
Profiles • Same features as INM 5.0, but now you can send profile data from the graph screen to either a printer or a file. (dbf or txt)	**Profiles** • You can easily graph and print profiles • You can build profiles by specifying flight procedures (i e. "Climb to 1000 feet", "Level at 1500 feet") • Enhanced Profile Generator: uses airport pressure, elevation, temperature, runway headwind and runway gradient to adjust profile, and modifies the approach profile as well as departure profiles.	**Profiles** • Profile Generator uses Airport elevation and temperature to adjust departure profiles
Noise data • Same as INM 5.0, but with further enhancement of the exposure fraction algorithm. • You now can write the data from the graphs to either the printer or a file. • (INM 5.2 only) Profile data for BAE146 and BAE300 enhanced to work at high altitude airports up to 6,000 AGL.	**Noise data** • You can easily graph and print noise-power-distance curves • New exposure fraction algorithm, improves accuracy of noise exposure calculations • Most standard aircraft have a maximum level noise-power-distance data	**Noise data** • EPNL and SEL tables for each standard aircraft
OAG data • Can process OAG data and setup operations input data *for scheduled flights only*		**OAG data** • Not Available
Census data/Tiger files • Can process 1990, 1992, 1994, and 1995 Tiger/line files to produce street maps.	**Census data/Tiger files** • Can process 1990,1992 Tiger/line files to produce street maps. (Can process 1994 Tiger/line files by using a separate DOS utility)	**Census data/Tiger files** • Not Available
Can process 1990 Census data for use in a model run.		

<table>
<tr><th>INM 5.1/5.2</th><th>INM 5.0</th><th>INM 4.11</th></tr>
<tr><td colspan="2">Terrain Data
• Terrain is also shown in the output graphics
• Acoustic Impedance term is now calculated at the observers' elevation.</td><td>Terrain Data
• Can process and use USGS terrain data (in the calculation of source-to-receiver slant distance only)</td></tr>
<tr><td>Model Tracks
• Same features as INM 5 0, plus you can overlay a CAD drawing in the Input Graphics window to use as guidance for drawing tracks.</td><td>Model Tracks
• Tracks can be defined in vector form (using degrees of turn) or by points.
• Can graphically edit tracks in the Input Track Graphics window (points-type tracks only)
• Overflight tracks can be used.
• New significant track testing algorithm (more discriminating)
• ARTS tracks can be used to create model (points-type) tracks
• Backbone- and sub- track capability for modeling dispersion within a flight corridor</td><td>Model Tracks
• Tracks can be defined in vector form only, with angles defined either by heading or degrees of turn.</td></tr>
<tr><td>Touch-and-go's
• Touch-and-go operations consist of two types of operations using a single flight track: a circuit flight (which starts and ends on the runway), and a pattern flight for multiple non-stop loops</td><td>Touch-and-go's
• Touch-and-go operations consist of three types of operations on three different flight tracks: a departure to pattern altitude, a pattern track for multiple non-stop loops, and an arrival track.</td><td>Touch-and-go's
• Defined by one track</td></tr>
<tr><td>Operations data entry
• Enhanced the filter for the view function.</td><td>Operations data entry
• View function allows the user to see the operations by plane type, track or by runway</td><td rowspan="2">Operations data entry
• Operations by percent or by frequency</td></tr>
<tr><td colspan="2">• Operations entered either as airport ops and group percents (corresponds to INM4 11 by percent method) or as flight operations (corresponds to INM4.11 by frequency method)</td></tr>
</table>

INM 5.1/5.2	INM 5.0	INM 4.11
Run Up Operations • Uses a XY Location and Heading of the aircraft • Assign a percent of thrust and duration for the event • Improved accuracy		**Run Up Operations** • Psuedo-takeoff event • Uses a 20' Runway (must be defined in the RUNWAYS section) • Uses the thrust value for a standard stage length or a user-defined takeoff profile
Grids • Contour Grid defined as other grids • Standard Grid (gives requested metric(s) only) (Limit 999) • Detailed Grid gives the requested data plus the top 97% contributors to that point) (Limit 999)		**Grids** • Separate contour parameter and grid point definition • Detailed grid point output gives the requested data plus the top 20 contributors to that point (Limit 20 points)
Output • contour generated with NMPLOT: interface built-in to the model (which allows contour file to be compatible with other noise model software outputs) • Can send graphic to DXF file • All results in database form ; easy to access • Easy to read CASE ECHO file		**Output** • Must read contours with INMPLOT • All inputs and text output in a large echo file

Appendix B: INM 6.0 Data Base

INMTYPE	Description	Group	WGT_CAT	OWNER_CAT	ENG_TYPE	P36 Noise	NOISE_ID	NUMB_ENG	THR_REST	MX_GW_TKO	MX_GW_LND	MX_DS_STOP	COEFF_TYPE	THR_STATIC
707	B707-120/JT3C	COM	H	C	J	1	JT4A	4	N	302400	188900	6682	J	10120
707120	B707-120B/JT3D-3	COM	H	C	J	1	JT3D	4	N	302400	188900	6893	J	14850
707320	B707-320B/JT3D-7	COM	H	C	J	1	JT3D	4	N	334000	247000	5622	J	19000
707QN	B707-320B/JT3D-7QN	COM	H	C	J	2	JT3DQ	4	N	334000	247000	5622	J	19000
720	B720/JT3C	COM	L	C	J	1	JT4A	4	N	223500	155600	4871	J	10120
720B	B720B/JT3D-3	COM	L	C	J	1	JT3D	4	N	234000	175000	5717	J	18000
727100	B727-100/JT8D-7	COM	L	C	J	1	3JT8D	3	N	169500	142500	4867	J	14000
727200	B727-200/JT8D-7	COM	L	C	J	1	3JT8D	3	N	217600	163300	5571	J	11895
727D15	B727-200/JT8D-15	COM	L	C	J	1	3JT8D	3	N	208000	169000	4922	J	15500
727D17	B727-200/JT8D-17	COM	L	C	J	2	3JT8DQ	3	N	208000	169000	5444	J	16000
727EM1	FEDX 727-100/JT8D-7	COM	L	C	J	3	3JT8E7	3	N	169500	142500	4867	J	14000
727EM2	FEDX 727-200/JT8D-15	COM	L	C	J	3	3JT8E5	3	N	208000	169000	4922	J	15500
727Q15	B727-200/JT8D-15QN	COM	L	C	J	2	3JT8DQ	3	N	208000	169000	4922	J	15500
727Q7	B727-100/JT8D-7QN	COM	L	C	J	2	3JT8DQ	3	N	169500	142500	4867	J	14000
727Q9	B727-200/JT8D-9	COM	L	C	J	2	3JT8DQ	3	N	191000	160000	5444	J	14500
727QF	UPS 727100 22C 25C	COM	L	C	J	3	TAY651	3	N	169000	142500	4448	J	15380
737	B737/JT8D-9	COM	L	C	J	1	2JT8D	2	N	109000	98000	3900	J	14500
737300	B737-300/CFM56-3B-1	COM	L	C	J	3	CFM563	2	N	135000	114000	4580	J	20000
7373B2	B737-300/CFM56-3B-2	COM	L	C	J	3	CFM563	2	N	139000	114000	4580	J	22000
737400	B737-400/CFM56-3C-1	COM	L	C	J	3	CFM563	2	N	150000	124000	5062	J	23500
737500	B737-500/CFM56-3B-1	COM	L	C	J	3	CFM563	2	N	138500	111000	4551	J	20000
737D17	B737-200/JT8D-17	COM	L	C	J	2	2JT8DQ	2	N	124000	107000	4244	J	16000
737QN	B737/JT8D-9QN	COM	L	C	J	2	2JT8DQ	2	N	109000	98000	3900	J	14500
747100	B747-100/JT9DBD	COM	H	C	J	2	JT9DBD	4	N	733000	516600	5727	J	33042
74710Q	B747-100/JT9D-7QN	COM	H	C	J	3	JT9DFL	4	N	733000	564000	6200	J	45500
747200	B747-200/JT9D-7	COM	H	C	J	3	JT9DFL	4	N	775000	564000	6200	J	45500
74720A	B747-200/JT9D-7A	COM	H	C	J	3	JT9D7Q	4	N	785000	564000	6200	J	46300
74720B	B747-200/JT9D-7Q	COM	H	C	J	3	JT9D7Q	4	N	800000	630000	6200	J	53000
747400	B747-400/PW4056	COM	H	C	J	3	PW4056	4	N	870000	630000	6989	J	56800
747SP	B747SP/JT9D-7	COM	H	C	J	3	JT9DFL	4	N	702000	475000	5911	J	45500
757PW	B757-200/PW2037	COM	L	C	J	3	PW2037	2	N	240000	198000	4790	J	38300
757RR	B757-200/RB211-535E4	COM	L	C	J	3	RR535E	2	N	220000	198000	4640	J	40100
767300	B767-300/PW4060	COM	H	C	J	3	2CF680	2	N	407000	320000	4710	J	60000
767CF6	B767-200/CF6-80A	COM	H	C	J	3	2CF680	2	N	315500	270000	4700	J	48000
767JT9	B767-200/JT9D-7R4D	COM	H	C	J	3	2CF680	2	N	351000	270000	4744	J	48000
A300	A300B4-200/CF6-50C2	COM	H	C	J	3	2CF650	2	N	364000	295000	5367	J	52500
A310	A310-300/CF6-80C2A2	COM	H	C	J	3	2CF650	2	N	331000	271000	4880	J	53500
A7D	A-7D,E/TF-41-A-1	MIL	L	M	J	0	TF41	1	N	42000	37100	7356	J	14500
BAC111	BAC111/SPEY MK511-14	COM	L	C	J	2	2JT8D	2	N	89600	82000	4449	J	11400
BAE146	BAE146-200/ALF502R-5	COM	L	C	J	3	AL502R	4	N	93000	81000	3770	J	6970
BAE300	BAE146-300/ALF502R-5	COM	L	C	J	3	AL502R	4	N	97500	84500	3960	J	6970
BEC58P	BARON 58P/TS10-520-L	GA	S	G	P	0	TSIO52	2	N	6100	6100	2733	P	779
C130	C-130H/T56-A-15	MIL	L	M	T	3	T56A15	4	N	155000	135000	4850	P	8026
CIT3	CIT 3/TFE731-3-100S	GA	L	G	J	3	TF7313	2	N	20000	17000	2770	J	3650
CL600	CL600/ALF502L	GA	L	G	J	3	AL502L	2	N	36000	33000	3300	J	7500
CL601	CL601/CF34-3A	GA	L	G	J	3	CF34	2	N	43100	36000	3550	J	9220
CNA441	CONQUEST II/TPE331-8	COM	S	C	T	0	TPE331	2	N	9900	9400	1939	P	1535
CNA500	CIT 2/JT15D-4	GA	L	G	J	3	JT15D1	2	N	14700	14000	3050	J	2500
COMJET	1985 BUSINESS JET	GA	L	G	J	1	CGAJ	2	N	19200	16200	2889	J	2900
COMSEP	1985 1-ENG COMP	GA	S	G	P	0	CGASEP	1	N	2440	2400	1156	P	605
CONCRD	CONCORDE/OLY593	COM	H	C	J	0	OLY593	4	N	400000	245000	10600	J	38100
CVR580	CV580/ALL 501-D15	COM	L	C	T	0	501D13	2	N	58000	52000	4256	P	8100
DC1010	DC10-10/CF6-6D	COM	H	C	J	3	CF66D	3	N	455000	363000	5820	J	40000

INMTYPE	Description	Group	WGT_CAT	OWNER_CAT	ENG_TYPE	P30 Noise	NOISE_ID	NUMB_ENG	THR_REST	MX_GW_TKO	MX_GW_LND	MX_DS_STOP	COEFF_TYPE	THR_STATIC
DC1030	DC10-30/CF6-50C2	COM	H	C	J	3	CF66D	3	N	572000	403000	5418	J	53200
DC1040	DC10-40/JT9D-20	COM	H	C	J	3	CF66D	3	N	555000	403000	6020	J	49400
DC3	DC3/R1820-86	COM	L	C	P	0	2R2800	2	N	28000	24500	2222	P	3120
DC6	DC6/R2800-CB17	COM	L	C	P	0	4R2800	4	N	106000	95000	3010	P	4180
DC820	DC-8-20/JT4A	COM	H	C	J	1	JT4A	4	N	317600	194400	6527	J	11850
DC850	DC8-50/JT3D-3B	COM	H	C	J	1	JT3D	4	N	325000	240000	5400	J	18000
DC860	DC8-60/JT3D-7	COM	H	C	J	1	JT3D	4	N	355000	275000	5310	J	19000
DC870	DC8-70/CFM56-2C-5	COM	H	C	J	3	CFM562	4	N	355000	258000	6500	J	22000
DC8QN	DC8-60/JT8D-7QN	COM	H	C	J	2	JT3DQ	4	N	355000	275000	5310	J	19000
DC910	DC9-10/JT8D-7	COM	L	C	J	1	2JT8D	2	N	90700	81700	5030	J	14000
DC930	DC9-30/JT8D-9	COM	L	C	J	1	2JT8D	2	N	114000	102000	4680	J	14500
DC950	DC9-50/JT8D-17	COM	L	C	J	2	2JT8DQ	2	N	121000	110000	4880	J	16000
DC9Q7	DC9-10/JT8D-7QN	COM	L	C	J	2	2JT8DQ	2	N	90700	81700	5030	J	14000
DC9Q9	DC9-30/JT8D-9QN	COM	L	C	J	2	2JT8DQ	2	N	114000	102000	4680	J	14500
DHC6	DASH 6/PT6A-27	COM	S	C	T	0	PT6A27	2	N	12500	12300	1500	P	2000
DHC7	DASH 7/PT6A-50	COM	L	C	T	3	PT6A50	4	N	41000	39000	2150	P	2850
DHC8	DASH 8-100/PW121	COM	L	C	T	3	PW120	2	N	34500	33900	3000	J	4750
DHC830	DASH 8-300/PW123	COM	L	C	T	3	PW120	2	N	43000	42000	3500	J	4918
F10062	F100/TAY 620-15	COM	L	C	J	3	TAY620	2	N	95000	85500	4560	J	13900
F10065	F100/TAY 650-15	COM	L	C	J	3	TAY650	2	N	98000	88000	4704	J	15100
F28MK2	F28-2000/RB183MK555	COM	L	C	J	2	RB183	2	N	65000	59000	3540	J	9850
F28MK4	F28-4000/RB183MK555	COM	L	C	J	2	RB183P	2	N	73000	64000	3546	J	9900
FAL20	FALCON 20/CF700-2D-2	GA	L	G	J	2	CF700	2	N	28700	27300	2490	J	4500
GASEPF	1985 1-ENG FP PROP	GA	S	G	P	0	SEPFP	1	N	2200	2200	1160	P	560
GASEPV	1985 1-ENG VP PROP	GA	S	G	P	0	SEPVP	1	N	3000	3000	1111	P	790
GIIB	GIIB/SPEY MK511-8	GA	L	G	J	2	SP5118	2	N	65500	58500	3200	J	11400
GIV	GIV/TAY 611	GA	L	G	J	3	TAY620	2	N	71700	58500	3200	J	13850
HS748A	HS748/DART MK532-2	COM	L	C	T	2	RDA532	2	N	46500	43000	3360	P	5150
IA1125	ASTRA 1125/TFE731-3A	GA	L	G	J	3	TF7313	2	N	23500	20700	3689	J	3700
KC135	KC135A/J57-P-59W	MIL	H	M	J	0	J57	4	N	300000	228000	6689	J	11750
KC135B	KC135B/JT3D-7	MIL	H	M	J	0	JT3D	4	N	300000	228000	6689	J	19000
L1011	L1011/RB211-22B	COM	H	C	J	3	RB2112	3	N	430000	358000	5693	J	42000
L10115	L1011-500/RB211-224B	COM	H	C	J	3	RB2112	3	N	510000	368000	6800	J	50000
L188	L188C/ALL 501-D13	COM	L	C	T	0	T56A7	4	N	116000	98100	4960	P	8000
LEAR25	LEAR 25/CJ610-8	GA	L	G	J	2	CJ610	2	N	15000	13500	2620	J	2950
LEAR35	LEAR 36/TFE731-2	GA	L	G	J	3	TF7312	2	N	18300	15300	3076	J	3500
MD11GE	MD-11/CF6-80C2D1F	COM	H	C	J	3	2CF68D	3	N	682400	433300	5131	J	61500
MD11PW	MD-11/PW 4460	COM	H	C	J	3	PW4460	3	N	682400	433300	4681	J	60000
MD81	MD-81/JT8D-209	COM	L	C	J	3	2JT8D2	2	N	140000	128000	4860	J	19300
MD82	MD-82/JT8D-217A	COM	L	C	J	3	2JT8D2	2	N	149500	130000	4920	J	20900
MD83	MD-83/JT8D-219	COM	L	C	J	3	2JT8D2	2	N	160000	139500	5200	J	21700
MU3001	MU300-10/JT15D-4	GA	L	G	J	3	JT15D5	2	N	14100	13200	2800	J	2500
SABR80	NA SABRELINER 80	GA	L	G	J	2	CF700	2	N	33720	27290	2490	J	3962
SD330	SD330/PT6A-45AR	COM	L	C	T	3	PT6A45	2	N	22900	22600	3650	P	2670
SF340	SF340B/CT7-9B	COM	L	C	T	3	CT75	2	N	27300	26500	3470	P	4067
A10A	FAIRCHILD THUNDERBOLT II TF34-GE-100 NM	MIL	L	M	J	0	AGE100	2	N	50000	33140	0	J	9065
A3	MCDONNELL DOUGLAS SKYWARRIOR J79-GE-8	MIL	L	M	J	0	GE-8	2	N	80000	62923	0	J	11000
A37	CESSNA DRAGONFLY J85-GE-17A NM	MIL	L	M	J	0	J8517A	2	N	14399	9556	0	J	2851
A4C	MCDONNELL DOUGLAS SKYHAWK J52-P-8A N	MIL	L	M	J	0	J52P8A	1	N	24490	16103	0	J	9293
A5C	J79-GE-10 • NM	MIL	L	M	J	0	GE-10	2	N	80000	62923	0	J	11870
A6A	GRUMMAN INTRUDER J52-P-8B NM	MIL	L	M	J	0	J52P8B	2	N	60400	45500	1900	J	9300
A7E	VOUGHT CORSAIR II TF41-A-2 NM	MIL	L	M	J	0	TF41A2	1	N	42000	29426	0	J	15000
AV8A	BAE HARRIER AV8A NM	MIL	L	M	J	0	AV-8A	1	N	0	0	0	J	0

INMTYPE	Description	Group	WGT_CAT	OWNER_CAT	ENG_TYPE	P38 Noise	NOISE_ID	NUMB_ENG	THR_REST	MX_GW_TKO	MX_GW_LND	MX_DS_STOP	COEFF_TYPE	THR_STATIC
AV8B	BAE HARRIER F402-RR-408 NM	MIL	L	M	J	0	RR-408	1	N	31000	25000	0	J	24000
B1	ROCKWELL LANCER F101-GE-102 NM	MIL	H	M	J	0	GE-102	4	N	477000	295000	0	J	31000
B2A	F118-GE-110 NM	MIL	H	M	J	0	GE-110	4	N	376000	169000	0	J	19000
B52BDE	BOEING STRATOFORTRESS J57P-19W NM	MIL	H	M	J	0	J57P19	8	N	420000	0	0	J	0
B52G	BOEING STRATOFORTRESS J57-P-43WB NM	MIL	H	M	J	0	J57P43	8	N	488000	0	0	J	14000
B52H	BOEING STRATOFORTRESS B52H NM	MIL	H	M	J	0	B-52H	8	N	0	0	0	J	0
B57E	ENGLISH ELECTRIC CANBERRA J57-PW-P-5 NM	MIL	L	M	J	0	J57P5	2	N	54800	0	0	J	11000
BUCCAN	RR SPEY RB 168-1A NM	MIL	L	M	J	0	RB168	2	N	45843	0	0	J	11330
C118	MCDONNELL DOUGLAS LIFT PW R-2800-CB17 N	MIL	L	M	P	0	RCB17	4	N	107000	85180	0	P	1865
C119L	FAIRCHILD FLYING BOX CAR C119L NM	MIL	L	M	P	0	C-119	2	N	74300	45000	0	P	0
C12	BEECH SUPER KING AIR HURON PW PT6A-41 NI	MIL	S	M	T	0	PT6A41	2	N	12500	12500	1760	P	850
C121	C121 NM	MIL	L	M	J	0	C-121	2	N	0	0	0	J	0
C123K	FAIRCHILD PW R-2800-99W AUX J85-GE17 NM	MIL	L	M	P	0	R2800	2	N	60000	29904	0	P	1715
C130AD	LOCKHEED HERCULES T56-A15 NM	MIL	L	M	T	0	C-130A	4	N	175000	175000	0	P	4508
C-130E	LOCKHEED HERCULES T56-A15 C130E NM	MIL	L	M	T	0	T56-15	4	N	175000	175000	0	J	4508
C130HP	LOCKHEED HERCULES C130HP NM	MIL	L	M	T	0	C-130H	4	N	0	0	0	P	0
C131B	GENERAL DYNAMICS CV34 PW R-2800-99W NM	MIL	L	M	J	0	R99W	2	N	41740	38000	0	J	2900
C135A	BOEING STRATOLIFTER PW J57-59W NM	MIL	H	M	J	0	J5759W	4	N	300000	157000	0	J	14000
C135B	BOEING STRATOLIFTER C135B NM	MIL	H	M	J	0	J5759	4	N	300000	157000	0	J	14000
C137	JT3D-3B NM	MIL	H	M	J	0	JT3D3B	4	N	322000	0	0	J	18000
C140	LOCKHEED JETSTAR TFE731-3 NM	MIL	L	M	J	0	TFE731	4	N	44507	38312	0	J	3000
C141A	LOCKHEED STARLIFTER TF-33-P-7 NM	MIL	H	M	J	0	TF33P7	4	N	342283	124892	0	J	21000
C17	F117-PW-100 NM	MIL	H	M	J	0	PW-100	4	N	585000	446000	3000	J	40700
C18A	JT41-11 NM	MIL	H	M	J	0	JT4111	4	N	331000	247000	2575	J	18000
C-20	GULFSTREAM III MK611-8RR NM	MIL	L	M	J	0	MK6118	2	N	74600	66000	3190	J	13850
C21A	LEARJET 35 TFE731-2-2B NM	MIL	L	M	J	0	TFE73B	2	N	18300	15567	0	J	3500
C22	BOEING 727 TRS18-1 NM	MIL	L	M	J	0	TRS181	3	N	0	0	0	J	0
C23	PT6A-65AR NM	MIL	L	M	J	0	PT6R65	2	N	25600	25100	1920	J	1424
C5A	LOCKHEED GALAXY TF39-GE-1 NM	MIL	H	M	J	0	TF39GE	4	N	769000	636000	2230	J	41000
C7A	DEHAVILLAND CARIBOU DHC-4A NM	MIL	L	M	P	0	PW123	2	N	0	0	0	P	0
C9A	MCDONNELL DOUGLAS DC9 JT8D-9 NM	MIL	L	M	J	0	JT8D9	2	N	121000	110000	4680	J	14500
CANBER	2 RR AVON 109 NM	MIL	L	M	J	0	AVON	2	N	54935	27947	0	J	7396
DOMIN	BRISTOL SIDDELEY VIPER 521 NM	MIL	S	M	J	0	VIPER	2	N	20497	0	0	J	3125
E3A	BOEING SENTRY TF33-PW-100A NM	MIL	H	M	J	0	PW100A	4	N	324909	160000	0	J	21000
E4	BOEING 747 CF6-50E NM	MIL	H	M	J	0	CF650E	4	N	800000	564000	6170	J	52500
E8A	JT3D-3B NM	MIL	H	M	J	0	JT3D3	4	N	336000	263000	0	J	18000
EA6B	J52-P-408 NM	MIL	L	M	J	0	P4A	2	N	65000	45500	1900	J	11200
F-111F	GENERAL DYNAMICS F111F NM	MIL	L	M	J	0	F111F	2	N	0	0	0	J	0
F100D	ROCKWELL SUPER SABRE PW J57-P-21A NM	MIL	L	M	J	0	J57P21	1	N	32839	32315	0	J	17000
F101B	PW J57-P-55 NM	MIL	L	M	J	0	J57P55	2	N	52408	44578	0	J	0
F102	PW J57-P-23 NM	MIL	L	M	J	0	J57P23	1	N	31505	0	0	J	17000
F104G	LOCKHEED STARFIGHTER J79-GE-11A NM	MIL	L	M	J	0	GE11A	1	N	28779	23000	0	J	16000
F105D	PW J75-P-19W NM	MIL	L	M	J	0	J75P19	1	N	52847	41321	0	J	26000
F106	PW J57-P-17 NM	MIL	L	M	J	0	J57P17	1	N	41440	37170	0	J	25000
F111AE	GENERAL DYNAMICS F111AE PW TF30-P-100 NI	MIL	L	M	J	0	TF30P1	2	N	100000	72418	0	J	25000
F111D	GENERAL DYNAMICS F111D NM	MIL	L	M	J	0	F111D	2	N	0	0	0	J	0
F117A	F404-GE-F1D2 NM	MIL	L	M	J	0	GEF1D2	2	N	52500	45385	0	J	11000
F14A	GRUMMAN TOMCAT TF30-P-414A NM	MIL	L	M	J	0	TF30P4	2	N	53000	36000	0	J	21000
F14B	GRUMMAN TOMCAT F110-GE-400 NM	MIL	L	M	J	0	GE400	2	N	74349	64277	0	J	27000
F15A	MCDONNELL DOUGLAS EAGLE F100-PW-100 N	MIL	L	M	J	0	PW100	2	N	56000	0	2500	J	25000
F15E20	MCDONNELL DOUGLAS EAGLE F100-PW-220 N	MIL	L	M	J	0	PW2205	2	N	81000	44300	0	J	23000
F15E29	MCDONNELL DOUGLAS EAGLE F100-PW-229 N	MIL	L	M	J	0	PW2295	2	N	0	0	0	J	29000
F16A	GENERAL DYNAMICS FALCON PW200 NM	MIL	L	M	J	0	PW200	1	N	0	0	0	J	0

INMTYPE	Description	Group	WGT_CAT	OWNER_CAT	ENG_TYPE	P38 Noise	NOISE_ID	NUMB_ENG	THR_REST	MX_GW_TKO	MX_GW_LND	MX_DS_STOP	COEFF_TYPE	THR_STATIC
F16GE	GENERAL DYNAMICS FALCON F110-GE-100 NM	MIL	L	M	J	0	GE100	1	N	42300	29261	0	J	29000
F16PW0	GENERAL DYNAMICS FALCON F100-PW-220 NM	MIL	L	M	J	0	PW220	1	N	42300	28058	0	J	24000
F16PW9	GENERAL DYNAMICS F FALCON F100-PW-229 N	MIL	L	M	J	0	PW229	1	N	42300	28809	0	J	29000
F-18	MCDONNELL DOUGLAS HORNET F404-GE-400 I	MIL	L	M	J	0	GE404	2	N	56000	36665	0	J	16000
F-4C	MCDONNELL DOUGLAS PHANTOM J79-6517A17	MIL	L	M	J	0	J79651	2	N	61795	46000	3780	J	18000
F5AB	NORTHRUP TIGER J85-GE-13 NM	MIL	L	M	J	0	GE-13	2	N	20576	19857	0	J	4080
F5E	NORTHRUP TIGER J85-GE-21B NM	MIL	L	M	J	0	GE21B	2	N	25152	25147	5000	J	5000
F8	VOUGHT F-8 CRUSADER PW J57-P-201 NM	MIL	L	M	J	0	J57P20	1	N	27500	0	0	J	18000
FB111A	GENERAL DYNAMICS FB111 PW TF30-P-100 NM	MIL	L	M	J	0	FB111A	2	N	100000	72418	0	J	25000
HARRIE	BAE HARRIER AV8 RR PEGASUS 6 NM	MIL	L	M	J	0	PEGAS	1	N	16000	11989	0	J	10198
HAWK	RR ADOUR MK151 NM	MIL	S	M	J	0	ADOUR	1	N	12000	7447	0	J	5350
HS748	RR DART RDA7 MK 536-2 NM	MIL	L	M	J	0	DART	2	N	0	46486	0	J	0
HUNTER	RR AVON RA28 NM	MIL	L	M	J	0	RA28	1	N	23990	13809	0	J	9913
JAGUAR	SEPECAT JAGUAR NM	MIL	L	M	J	0	JAGUA	2	N	34100	0	0	J	0
KC10A	CFG-50C2 NM	MIL	H	M	J	0	CFG50C	3	N	590000	403000	5350	J	53000
KC-135	BOEING STRATOTANKER KC135R F108-CF100 N	MIL	H	M	J	0	F108CF	4	N	323000	0	0	J	22000
KC97L	BOEING STRATOFREIGHTER PW R-436-59B NM	MIL	L	M	P	0	R43659	4	N	0	0	0	P	2570
LIGHTN	RR AVON 302C NM	MIL	L	M	J	0	302C	2	N	41876	0	2880	J	13218
MD9025	MD-90/V2525-D5	COM	L	C	J	3	V2525	2	Y	156000	142000	3000	J	25000
MD9028	MD-90/V2528-D5	COM	L	C	J	3	V2525	2	Y	156000	142000	3000	J	28000
NIMROD	RR SPEY MK511 NM	MIL	L	M	J	0	SPEY	4	N	191748	0	0	J	10947
OV10A	ROCKWELL BRONCO T76 NM	MIL	L	M	T	0	T76	2	N	14466	10721	0	J	715
P3A	LOCKHEED ORION T56-A-14 NM	MIL	L	M	T	0	T56A14	4	N	142000	104000	0	J	4910
PHANTO	MCDONNELL DOUGLAS PHANTOM F-4 NM	MIL	L	M	J	0	PHANTO	2	N	0	0	0	J	0
PROVOS	BRISTON SIDDELEY VIPER 11 NM	MIL	S	M	J	0	VIP11	1	N	7295	4654	0	J	2454
S3A&B	LOCKHEED VIKING TF34-6E-2 NM	MIL	L	M	J	0	TF346E	2	N	52539	45914	1600	J	9275
SR71	JT11D-20B NM	MIL	L	M	J	0	JT11D2	2	N	170000	60000	2600	J	32500
T-38A	NORTHRUP TALON T-38A NM	MIL	S	M	J	0	TJ85	2	N	12093	0	0	J	3850
T1	LOCKHEED SEA STAR JT15D-5 NM	MIL	L	M	J	0	JT15DM	1	N	16100	15700	0	J	2965
T29	GENERAL DYNAMICS CV34 PW R-2800-99W NM	MIL	L	M	P	0	T-29	2	N	41740	0	0	P	0
T-2C	ROCKWELL BUCKEYE J85-6E-4 NM	MIL	L	M	J	0	J856E4	2	N	13284	12646	0	J	2950
T3	AEIO-540-D4A5 NM	MIL	S	M	J	0	AEIO54	1	N	2525	2738	0	J	260
T33A	LOCKHEED T-33A J33-35 NM	MIL	L	M	J	0	J3335	2	N	0	0	0	J	5203
T34	BEECH MENTOR (BE45) PT6A-25 NM	MIL	S	M	P	0	PT6A25	1	N	4300	4300	0	P	715
T37B	CESSNA 318 J69-T-25 NM	MIL	S	M	J	0	J69T25	2	N	6625	0	0	J	1025
T39A	ROCKWELL SABRELINER GEJ85 NM	MIL	L	M	J	0	GEJ85	2	N	0	0	0	J	0
T41	CESSNA 172 O-320-E2D NM	MIL	S	M	P	0	O320E2	1	N	0	0	0	P	110
T42	BEECH BARON (BE55) NM	MIL	S	M	P	0	IO-550	2	N	5500	5400	2450	P	300
T-43A	BOEING 737 T43A NM	MIL	L	M	J	0	T-43A	2	N	0	0	0	J	0
T44	T44 NM	MIL	L	M	J	0	T-44	2	N	0	0	0	J	0
T45	PT6A-45AG NM	MIL	L	M	J	0	F405RR	2	N	14081	15129	0	J	5450
TORNAD	RB199-34R NM	MIL	L	M	J	0	RB1993	2	N	45000	30620	1215	J	16075
TR1	J75-P-13B NM	MIL	L	M	J	0	J75P1B	1	N	40000	0	0	J	17000
U2	LOCKHEED U2 J75-P-13 NM	MIL	L	M	J	0	J75P13	1	N	40000	10000	0	J	11000
U21	BEECH UTE PW PT6A-20 NM	MIL	S	M	T	0	PT6A20	2	N	12500	12500	1760	P	850
U4B	ROCKWELL SUPER COMMANDER 1G0-540B1A	MIL	S	M	P	0	540B1A	2	N	0	0	0	P	350
U6	DEHAVILLAND BEAVER PW R-985 DHC-2 NM	MIL	S	M	P	0	R985	1	N	0	0	0	P	330
U8F	BEECH SEMINOLE 0-480-1 D50 NM	MIL	S	M	P	0	C480	2	N	0	0	0	P	254
VC10	RR CONWAY RC0-42 NM	MIL	H	M	J	0	CONWY	4	N	311912	147875	0	J	20996
VICTOR	BRITISH AEROSPACE VICTOR NM	MIL	L	M	J	0	VICTO	4	N	0	0	0	J	0
VULCAN	BRITTEN NORMAN VULCAN RR OLYMPUS 301 I	MIL	H	M	J	0	RROLYM	4	N	200564	0	0	J	20007
YC14	GE CF6-50D NM	MIL	L	M	J	0	CF650D	2	N	237000	181000	0	J	51000
YC15	PWJT8D-17 NM	MIL	L	M	J	0	JT8D17	4	N	0	0	0	J	16000

INMTYPE	Description	Group	WGT_CAT	OWNER_CAT	ENG_TYPE	P36 Noise	NOISE_ID	NUMB_ENG	THR_REST	MX_GW_TKO	MX_GW_LND	MX_DS_STOP	COEFF_TYPE	THR_STATIC
C130E	C-130E/T56-A-7	MIL	L	M	T	0	T56A7	4	N	155000	130000	4670	P	7063
KC135R	KC135R/CFM56-2B-1	MIL	H	M	J	0	CFM56A	4	N	324000	244000	6556	J	22000
F4C	F-4C/J79-GE-15	MIL	L	M	J	0	J79	2	N	52000	40000	4444	J	10900
737N17	B737-200/JT8D-17 Nordam B737 LGW Hushkit	COM	L	C	J	3	2JT8DN	2	N	124000	107000	4244	J	16000
737N9	B737/JT8D-9 Nordam B737 LGW Hushkit	COM	L	C	J	3	2JT8DN	2	N	109000	98000	3900	J	14500
777200	Boeing 777-200 GE90-76B	COM	H	C	J	3	GE9076	2	N	535000	445000	4450	J	77000
DC93LW	DC9-30/JT8D-9 w/ ABS Lightweight hushkit	COM	L	C	J	3	2JT8DL	2	N	114000	102000	4680	J	14500
DC95HW	DC9-50/JT8D17 w/ ABS Heavyweight hushkit	COM	L	C	J	3	2JT8DH	2	N	121000	110000	4880	J	16000
EMB145	Embraer 145 ER/Allison AE3007	COM	L	C	J	3	AE3007	2	N	45420	41230	4232	J	7500
F18EF	Boeing F-18E/F / F404-GE-400 NM	MIL	L	M	J	0	F18EF	2	N	66000	0	0	J	22000
JPATS	Raytheon T-6A Texan II / PT6A-68 NM	MIL	S	M	T	0	PT6A68	1	N	6300	0	0	P	1100
P3C	LOCKHEED ORION / T56-A-14 NM	MIL	L	M	T	0	T56-14	4	N	135000	104000	0	J	4910
DHC6QP	DASH 6/PT6A-27 Raisbeck Quiet Prop Mod	COM	S	C	T	0	RAISQP	2	N	12500	12300	1500	P	2000
A340	A340-211/CFM 56-5C2	COM	H	C	J	3	CF565C	4	N	566500	399000	6000	J	31900
EMB14L	Embraer 145 LR / Allison AE3007A1	COM	L	C	J	3	AE3007	2	N	48500	42550	4232	J	7500
EMB120	Embraer 120 ER/ Pratt & Whitney PW118	COM	L	C	T	3	EPW118	2	N	26433	25794	5571	J	4000
A320	A320-211 CFM56-5A1	COM	L	C	J	3	CFM565	2	N	162000	142000	2930	J	25800
CNA172	Cessna 172R / Lycoming IO-360-L2A	GA	S	G	P	0	IO360L	1	N	2450	2450	1695	P	436
CNA206	Cessna 206H / Lycoming IO-540-AC	GA	S	G	P	0	IO540	1	N	3600	3600	1880	P	798
CNA20T	Cessna T206H / Lycoming TIO-540-AJ1A	GA	S	G	P	0	TIO540	1	N	3600	3600	1880	P	825
A330	Airbus A330-301 / CF6-80 E1A2	COM	H	C	J	3	CF680E	2	N	467400	383600	3252	J	64900
737700	737700/CFM56-7B	COM	L	C	J	3	CF567B	2	N	154500	128000	4445	J	24000
CNA55B	Cessna 550 Citation Bravo / PW530A	GA	S	G	J	0	PW530A	2	N	14800	13500	3010	J	2863

Appendix C: INM 6.0 Substitution List

SUB_ID	Description	INMTYPE
7073SH	707-300 ADV/C w/Shannon H/K	707QN
707C56	707 w/CFM56	DC870
717	BOEING 717-200 (MD-95) 114000 LBS	F10062
717ER	BOEING 717-200 (MD-95) 121000 LBS	F10062
720TJ	B720 Turbojet	DC820
727RR1	727-100 with RR TAY 650 eng.	727EM1
727RR2	727-200 with RR TAY 650 eng.	727EM2
73717A	737-100 w/JT8D-7A	737QN
737215	737-200 ADV w/JT15QN	737D17
737222	Boeing 737-222	737QN
747122	Boeing 747-122	74720A
7472G2	747-200 w/JT9D-7R4G2	747200
7473G2	747-300 w/JT9D-7R4G2	74720B
747R21	747 w/CF6 or RB211 engines	74720B
767400	Boeing 767-400	767300
A319	Airbus A-319	A320
A321	Airbus A-321	A320
AA5A	Grumman Cheetah (AA5A)	GASEPF
AC50	Commander 500	BEC58P
AC56	Commander 560	BEC58P
AC69	Jet Prop Commander	CNA441
AC95	Aero Commander 695	CNA441
AEROJT	Aero Commander Jet Commander	LEAR25
AN124	Antonov-124	74720B
AN26	Antonov-26	CVR580
AN74TK	Antonov-74	DC9Q9
ATR42	Avions de Transport Regional ATR-42	DHC8
ATR72	Avions de Transport Regional ATR-72	HS748A
BAEATP	British Aerospace Advanced Turboprop ATP	HS748A
BAEJ31	British Aerospace BAe Jetsream 31	DHC6
BAEJ41	British Aerospace Bae Jetstream 41	SF340
BEC100	Beech King Air 100	CNA441
BEC18	Beechcraft Model 18	BEC58P
BEC190	Beech 1900	DHC6
BEC200	Beech Super King Air 200	DHC6
BEC20A	Beech Starship 2000	SD330
BEC23	Beechcraft Model 23 Musketeer	GASEPF
BEC24	Beechcraft Model 24 Sierra	GASEPF
BEC300	Beech Super King Air 300	DHC6
BEC30B	Beech Super King Air 300B	DHC6
BEC33	Beechcraft Model 33 Debonair/Bonanza	GASEPV
BEC400	Beechcraft Beechjet 400	LEAR35
BEC45	Beechcraft Model 45 Mentor (T34A & T34B)	GASEPV
BEC50	Beechcraft Model 50 Twin Bonanza	BEC58P
BEC55	Beechcraft Model 55 Barron	BEC58P
BEC58	Beechcraft Model 58 Barron	BEC58P
BEC60	Beechcraft Model 60 Duke	BEC58P
BEC65	Beechcraft Model 65 Queen Air	BEC58P
BEC76	Beechcraft Model 76 Duchess	BEC58P
BEC80	Beechcraft Model Queen Air 80 series	BEC58P
BEC90	Beech King Air C90	CNA441
BEC95	Beechcraft Model 95 Travel Air	BEC58P
BEC99	Beech Airliner Model 99	DHC6
BEC9F	Beech F90 Super King Air	CNA441

SUB_ID	Description	INMTYPE
BECM35	Beechcraft Model M35 Bonanza	GASEPV
BL14	Bellanca Cruisair	GASEPF
BL26	Bellanca Super Viking Model 17-30A	GASEPF
BLCH10	Bellanca Champion Citabria CH10	GASEPF
BN2A	Britten-Norman BN-2A Islander	BEC58P
BN3	Britten-Norman BN-3 Nymph	GASEPF
C141	Lockheed C-141 Starlifter	707320
C17A	Globemaster III C-17	DC870
C20	US Military Gulfstream III	GIIB
C20A	US Military Gulfstream III	GIIB
C26	Military Metro/Merlin	DHC6
C45	Military Twin Beech 18	BEC58P
C5	Lockheed Galaxy	74720B
C8	US Army DHC-5 Buffalo	HS748A
C9B	Navy DC9-30 SkyTrain	DC9Q9
CA212	CASA C-212 Aviocar	DHC6
CAN235	CACA-Nurtanio CN-235 Airtech	SF340
CC138	Canadian Air Force DHC-6 Twin Otter	DHC6
CL610	Canadair CL-610 Challenger E	CL601
CLREGJ	Canadair Regional Jet	CL601
CNA150	Cessna 150	CNA172
CNA152	Cessna 152	CNA172
CNA170	Cessna 170	CNA172
CNA177	Cessna 177 Cardinal	CNA172
CNA17B	Cessna 177B or RG Cardinal	GASEPV
CNA180	Cessna Skywagon	CNA206
CNA182	Cessna 182 Skylane	CNA206
CNA185	Cessna Skywagon	CNA206
CNA205	Cessna 205 Super Skywagon	CNA206
CNA207	Cessna 207 Turbo Stationair	CNA20T
CNA208	Cessna 208 Caravan I	GASEPF
CNA210	Cessna 210 Centurion/II	CNA206
CNA303	Cessna 303 Crusader	BEC58P
CNA305	Cessna 305/L-19 or O-1 Bird Dog	GASEPF
CNA310	Cessna 310	BEC58P
CNA320	Cessna 320 Skynight	BEC58P
CNA335	Cessna 335	BEC58P
CNA336	Cessna 336 Skymaster	BEC58P
CNA337	Cessna 337 Super Skymaster	BEC58P
CNA340	Cessna 340	BEC58P
CNA401	Cessna 401	BEC58P
CNA402	Cessna 402	BEC58P
CNA404	Cessna 404 Titan	BEC58P
CNA414	Cessna 414 Chancellor	BEC58P
CNA421	Cessna 421 Golden Eagle	BEC58P
CNA425	Cessna 425 Corsair/Conquest I	CNA441
CNA501	Cessna Citation I Single Pilot (SP)	CNA500
CNA525	Cessna Citation Jet	CNA500
CNA550	Cessna Model 550 Citation II	MU3001
CNA551	Cessna Citation II Single Pilot (SP)	MU3001
CNA560	Cessna 560 Citation V	MU3001
CNA650	Cessna 650 Citation VII	CIT3
CNA750	Cessna Citation X	CL600
CNACAR	Cessna AGCARRYALL	GASEPV

SUB_ID	Description	INMTYPE
CNATRK	Cessna AGTRUCK	GASEPV
CNAWAG	Cessna AGWAGON	GASEPV
CNV240	Convair 240	DC3
CNV600	Convair 600	HS748A
CNV640	Convair 640	HS748A
CNV880	Convair 880	DC820
CNV990	Convair 990	707
CONSTE	Lockheed Constellation	DC6
DALPHA	Dassault Alpha Jet	FAL20
DBMERC	Dassualt Mercure	737D17
DC4	Douglas DC-4	DC6
DC7	Douglas DC-7	DC6
DC86BT	DC8-62/63 w/Burbank Treatment	DC8QN
DC9317	DC930 w/JT8D-17 &15	DC9Q9
DC937A	DC930 w/JT8D-7 & 7A	DC9Q9
DC9411	DC940 w/JT8D-11	DC9Q9
DHC2	De Havilland DHC-2 Beaver	GASEPV
DHC4	De Havilland DHC-4 Caribou	DC3
DO228	Dornier-228	DHC6
DO328	Dornier-328	DHC8
EMB110	Embraer Bandeirante 110	DHC6
EMB135	Embraer EMB-135	CL600
F10	Douglas Skyknight	LEAR25
F90	Beech Super King Air	CNA441
FAL10	Falcon 10	LEAR35
FAL200	Falcon 200	LEAR35
FAL20A	Falcon 2000	CL600
FH227	Fairchild-Hiller F-227 (Fokker 27 Elong)	HS748A
FH27	Fairchild-Hiller F-27 (Fokker 27)	HS748A
FK27	Fokker F.27	HS748A
FK50	Fokker 50	DHC830
FK70	Fokker 70	F10062
G164AG	GrummanAmerican Super Agcat	GASEPV
GA7	Grumman Cougar (GA7)	BEC58P
GC1	Vought Swift	GASEPF
GROB15	Burkhart Grob G 115	GASEPF
GSPORT	Great Lakes Sport	GASEPF
GULF1	Gulfstream I (G159)	HS748A
GULF2	Gulfstream II	GIIB
GULF3	Gulfstream III	GIIB
GULFCO	Gulfstream Commander	CNA441
HS125	Hawker-Siddeley 125	LEAR25
HS1258	Bae (Hawker-Siddeley) 125-800	LEAR35
IA1123	IAI 1123 Westwind	LEAR25
IA1124	IAI 1124 Westwind	IA1125
IARAVA	IAI Arava	DHC6
IL114	Ilyushin-114	CVR580
IL62	Ilyushin-62	707QN
IL76	Ilyushin-76	DC8QN
IL86	Ilyushin-86	DC8QN
IL96	Illyushin-96	747200
JST1TF	Jetstar 1 Turbofan	LEAR35
JST1TJ	Jetstar 1 Turbojet	LEAR25
JST2TF	Lockheed Jetstar 2	LEAR35

SUB_ID	Description	INMTYPE
KC135E	Boeing KC135 Stratotanker (Re-engined)	707320
LA42	Lake LA-4-200 Buccaneer	GASEPV
LEAR23	Learjet 23	LEAR25
LEAR24	Learjet 24	LEAR25
LEAR31	Learjet 31	LEAR35
LEAR36	Learjet 36	LEAR35
LEAR45	Learjet 45	LEAR35
LEAR55	Learjet 55	LEAR35
LEAR60	Learjet 60	LEAR35
LOADMS	Ayres LoadMaster	SD330
M20J	Mooney 201LM and 205 (M20J)	GASEPV
M20K	Mooney 252TSE (M20K)	GASEPV
M20L	Mooney Pegasus (M20L)	GASEPV
MB339C	Aermacchi M B 339-C	A7D
MD80	McDonnell-Douglas MD80	MD81
MD87	McDonnell-Douglas MD87	MD81
MD88	McDonnell-Douglas MD88	MD83
MD8819	MD88 w/JT8D-119	MD81
MU2	Mitsubishi MU-2	DHC6
MU300	Mitsubishi Diamond MU-300	CNA500
N24	Gov Aircraft Factories N24	CNA441
NRD262	Nord-Aviation NORD-262	SD330
OV1	Grumman Mohawk OV-1	DHC6
PA17	Piper PA-17 Vagabond	GASEPF
PA18	Piper PA-18 Super Cub	GASEPF
PA22CO	Piper PA-22 Colt	GASEPF
PA22TR	Piper PA-22 Tripacer	GASEPF
PA23AP	Piper PA-23-235 Apache	BEC58P
PA23AZ	Piper PA-23 Aztec	BEC58P
PA24	Piper PA-24 Comanche	GASEPV
PA25	Piper PA-25 Pawnee	GASEPV
PA28AR	Piper PA-28-181 Archer II	GASEPF
PA28C2	Piper PA-28-235E Cherokee 235E	GASEPV
PA28CA	Piper PA-28R-200 Cherokee Arrow II	GASEPV
PA28CC	Piper PA-28-180 Cherokee Challenger	GASEPF
PA28CH	Piper PA-28-140 Cherokee 140	GASEPF
PA28DK	Piper PA-28-236 Dakota	GASEPV
PA28WA	Piper PA-28-161 Warrior II	GASEPF
PA30	Piper PA-30 Twin Comanche	BEC58P
PA31	Piper PA-31 Navajo	BEC58P
PA31CH	Piper PA-31-350 Chieftain	BEC58P
PA31T	Piper PA-31T Cheyenne	CNA441
PA32C6	Piper PA-32 Cherokee Six	GASEPV
PA32LA	Piper PA-32R-300 Lance	GASEPV
PA32SG	Piper PA-32 Saratoga	GASEPV
PA34	Piper PA-34 Seneca	BEC58P
PA36	Piper 36 Brave	BEC58P
PA38	Piper PA-38-112 Tomahawk	GASEPF
PA39	Piper PA-39 Twin Comanche C/R	BEC58P
PA42	Piper PA-42 Cheyenne III	CNA441
PA44	Piper 44 Seminole	BEC58P
PA46	Piper PA-46 Malibu	GASEPV
PA60	Piper Aerostar Model 600/700	BEC58P
PA61	Piper PA-61 Aerostar Model 601	BEC58P

SUB_ID	Description	INMTYPE
PC6	Pilatus PC-6	GASEPV
PITTS1	Pitts S-1 Special	GASEPF
RJ70	RJ70	BAE146
RWCM12	Rockwell Commander 112 (Alpine)	GASEPF
RWCM14	Rockwell Commander 114 (Gram Turismo)	GASEPV
RWCM50	Rockwell Shrike Commander 500S	BEC58P
RWCM69	Rockwell Turbo Commander 690	CNA441
RWCMTH	Rockwell Thrust Commander (SR2)	GASEPV
S2	Grumman S-2 Tracker	DC3
S212	Siai Marchetti S212	CNA500
SA226	Swearingen Metro II	DHC6
SA227	Swearingen Metro III	DHC6
SAAB20	SAAB 2000	HS748A
SABR40	Sabreliner 40	LEAR25
SABR60	Sabreliner 60	LEAR25
SABR65	Sabreliner 65	LEAR35
SABR70	Sabreliner 70	LEAR25
SABR75	Sabreliner 75	LEAR25
SAMER2	Swearingen Merlin II	CNA441
SAMER3	Swearingen Merlin III	CNA441
SAMER4	Swearingen Merlin IV	DHC6
SD360	Shorts 360	SD330
SE210	Aerospatiale Caravelle	737
SF260M	Siai Marchetti SF260M	GASEPV
SN600	Aerospatiale SN 600 Corvette	CNA500
T37	USAF Cessna T37 or 318	LEAR25
T38	USAF Northrop T38	LEAR25
T43A	USAF 737-200	737
T47A	US Navy Cessna Citation S/II	CNA500
TAYF19	Taylorcraft Sprtsman 100 (F19)	GASEPF
TED600	Ted Smith Aerostar 600	BEC58P
TU134	Tupolev-134	DC930
TU154	Tupolev-154	727D17
TU204	Tupolev-204	757RR
TU334	Tuploev-334	F10065
J3	USAF Cessna Model 310	BEC58P
JV18	US Military DHC-6 Twin Otter	DHC6
/C10TF	Vickers VC10 TurboFan	707
/C10TJ	Vickers VC10 TurboJet	DC820
/C2	Vickers VC2 Viscount	L188
(AK42	Yakolev Yak-42	727100
(S11	Nihon Aeroplane (NAMC) YS-11	HS748A
(S11C	Nihon Aeroplane (NAMC) YS-11 Cargo	HS748A

Appendix E: INM 6 Computed SEL Reference Table

SELS calculated by INM version 6 0a - under standard atmospheric conditions

INM ver 6 0a

INM Aircraft	Part 36 Stage	Description	(all Takeoff SELs are for Stage Length 1) Distance from Brake Release for Takeoff (in feet) 15000	20000	25000	30000	35000	60000	Arrival SELs Distance to Landing Threshold (in feet) 5000	10000	15000	20000	25000	50000
707	1	B707-120/JT3C	102 7	98 1	95 6	92 5	90 2	83 1	108 1	102 8	99 4	96 8	94 5	86 6
707120	1	B707-120B/JT3D-3	101 6	96 6	94 0	91 8	89 7	82 0	110 0	105 1	101 5	98 4	95 7	85 7
707320	1	B707-320B/JT3D-7	103 7	99 1	96 4	94 4	92 5	85 2	111 0	106 2	102 6	99 2	95 2	83 0
707QN	2	B707-320B/JT3D-7QN	102 9	97.3	95 1	93 1	91 4	86 5	102 6	97 8	94 4	91 6	89 1	81 7
720	1	B720/JT3C	98 0	94 2	91 0	88 7	87 0	78 8	108 0	102 6	99.2	96 6	94 3	86 3
720B	1	B720B/JT3D-3	98 6	95 0	92 2	89 9	87 6	80 4	108 1	103 2	99 5	96 2	92 9	81 8
727100	1	B727-100/JT8D-7	103 7	98 2	95 3	93 3	91 6	85 4	103 5	98 4	95 0	92 5	90 1	80 7
727200	1	B727-200/JT8D-7	106 4	103 5	101 4	99 4	97 3	89 4	103 4	98 2	94 9	92 5	90,8	84 8
727D15	1	B727-200/JT8D-15	109 5	100 2	97 7	95 9	94 3	88 9	103 6	98 4	95 2	92 4	89,2	80 6
727D17	2	B727-200/JT8D-17	109 7	102 5	99 9	98 0	96 0	89 2	97 7	94.0	91 6	89 4	87 0	78 2
727EM1	3	FEDX 727-100/JTD8-7	98 8	93 8	90 6	88 4	86 8	79 9	96 9	92 9	89 9	87 4	85 0	75 7
727EM2	3	FEDX 727-200/JTD8-15	103 3	95 8	93 1	91 1	89 5	83 7	97 3	93 2	90 5	88 0	85 1	77 1
727Q15	2	B727-200/JT8D-15QN	109 0	99 3	96 9	95 2	93 6	88 2	97 7	94 0	91 6	89 2	86 0	77 8
727Q7	2	B727-100/JT8D-7QN	102 8	97.1	94 4	92 4	90.7	84 5	97.3	93 6	91 2	89 1	86 9	77 9
727Q9	2	B727-200/JT8D-9	105 6	102 7	100 2	95 9	94 2	87 5	97 7	94 0	91 6	89 5	87 1	78 2
727QF	3	UPS 727-100	94 5	88 7	86 1	84 2	82 9	76 5	93 0	88 8	86 1	82 9	78 2	71 4
737	1	B737/JT8D-9	98 7	95 4	93 0	90 6	89 0	82 2	100 3	95 1	91 6	89 0	86 8	78 0
737300	3	B737-300/CFM56-3B-1	85 4	82 6	80 1	78 3	76 4	69 9	94 1	90 0	87 2	84 9	82 7	74 8
7373B2	3	B737-300/CFM56-3B-2	85 7	83 0	80 1	78 4	76 6	69 5	94 1	90 0	87 2	84 9	82 7	74 9
737400	3	B737-400/CFM56-3C-1	87 0	84 3	81 3	79 8	77 9	71 6	94 2	90 1	87 3	85 0	82 6	75 0
737500	3	B737-500/CFM56-3B-1	85 6	82 8	80 4	78 5	76 8	70 2	94 2	90 0	87 2	84 9	82 7	74 8
737D17	2	B737-200/JT8D-17	99 6	96 6	94 5	92 2	90 8	83 6	94 0	90 3	87 9	85 8	83 7	75 6
737N17	3	B737-200/JT8D-17 Nordham	97 8	94 6	92 2	89 8	88 2	81.4	93 6	90 0	87 5	85 5	83 4	75 2
737N9	3	B737-200/JT8D-9 Nordham E	93 6	90 4	88 0	85 7	84 2	77.6	93 3	89 8	87 2	84 8	82 4	73 1
737QN	2	B737/JT8D-9QN	94 8	91 6	89 4	87 2	85 7	78 9	93 8	90 3	87 7	85 4	82 9	73 7
747100	2	B747-100/JT9DBD	101 8	97 6	95 7	94 0	92 4	86 2	105 4	100 8	97 7	95 2	93 1	85 7
74710Q	3	B747-100/JT9D-7QN	96 0	92 1	89 7	87 7	85 9	79 8	101 8	97 5	94 5	91 7	88 5	80 7
747200	3	B747-200/JT9D-7	97 6	93 7	91 4	89 4	87 7	81 5	101 8	97 5	94 5	91 7	88 5	80 6
74720A	3	B747-200/JT9D-7A	96 9	92 5	90 6	88 7	86 7	80 6	102 4	98 5	95 8	93 6	91 6	85 0
74720B	3	B747-200/JT9D-7Q	98 2	93 4	91 1	89 6	87 7	81 7	102 5	98 6	95 9	93 6	91 5	84 9
747400	3	B747-400/PW4056	95 2	90 0	87 7	86 2	84 4	78 9	102 0	97 5	94 5	92 2	90 1	83 3
747SP	3	B747SP/JT9D-7	92 6	89 7	87 3	85 3	83 4	77 0	101 3	96 9	93 9	91 2	88 3	80 4
757PW	3	B757-200/PW2037	83 5	80 1	77 5	75 5	73.6	67 4	94 7	90 6	87 9	85 6	83 4	75 0
757RR	3	B757-200/RB211-535E4	84 3	81 3	78 5	76 9	75 1	68 9	93.0	88 8	86 1	84 0	82 0	74 3

SELS calculated by INM version 6 0a - under standard atmospheric conditions

INM ver 6 0a

INM Aircraft	Part 36 Stage	Description	(all Takeoff SELs are for Stage Length 1) Distance from Brake Release for Takeoff (in feet) 15000	20000	25000	30000	35000	60000	Arrival SELs Distance to Landing Threshold (in feet) 5000	10000	15000	20000	25000	50000
767300	3	B767-300/PW4060	91 0	88 0	85 1	83 5	81 7	76 0	97 3	93 3	90 6	88 3	86 2	78 2
767CF6	3	B767-200/CF6-80A	88 6	85 5	83 2	80 8	79 3	73 6	96.5	92 5	89 8	87 6	85 4	77.7
767JT9	3	B767-200/JT9D-7R4D	89 1	85 9	83 3	81 3	79 5	73 6	96 6	92 6	89 9	87 6	85 5	77 8
777200	3	B777-200	87 6	84 3	81 8	79 7	77 8	71 2	96 2	91 9	89 0	85 1	82 4	80 0
A300	3	A300B4-200/CF6-50C2	91 8	87 1	84 8	82 7	81 2	74.4	97.4	92 8	89 7	87 1	84 6	77 0
A310	3	A310-300/CF6-80C2A2	88 5	86 6	83 4	81 7	79 8	71 3	97 1	92 4	89 3	86 6	84 0	77 0
A320	3	A320-211/CFM56-5A-1	86 8	83 2	80 6	78 8	76 8	68 6	94 3	89 9	87 0	84 6	82 5	75 5
A340	3	A340-211	93 7	89 5	86 1	84	82 2	75 8	98 8	93 5	90 5	88 2	85 7	79 1
A7D	-	A-7D,E/TF-41-A-1	110 7	106 0	102.2	99 0	96 0	83 9	104 4	99 9	96 9	93 7	89 5	80 9
BAC111	2	BAC111/SPEY MK511-14	96 8	91 7	89 1	87 3	86 0	79 2	100 2	95.0	91 5	88.7	85 8	77 1
BAE146	3	BAE146-200/ALF502R-5	89 4	86 1	83 5	81 1	79 3	73 0	92 4	88.6	86 0	83 5	80 8	74 0
BAE300	3	BAE146-300/ALF502R-5	90 0	87.3	84 4	82 2	80 2	74 0	92 3	88 6	85 9	83 4	80 8	73 9
BEC58P	-	BARON 58P/TS10-520-L	82.1	80 6	79 3	78 2	77 3	74 0	85 9	82 3	80 1	78 2	76 2	70 5
C130	-	C-130H/T56-A-15	92 8	89 1	87 2	85 5	84 1	78 2	95 9	91.8	89 1	86 8	84 5	77 5
C130E	-	C-130E/T56-A-7	89 8	86 7	84 6	83 1	81 8	77 4	95 9	91 9	89 1	86 9	84 7	77 3
CIT3	3	CIT 3/TFE731-3-100S	88 2	82 1	80 2	78 0	76 3	70 2	84.9	80 9	78 2	75 8	73 3	65 1
CL600	3	CL600/ALF502L	86 1	80 8	78 4	76 4	74 8	68 9	87 6	83 3	80 3	77 4	74 0	64 1
CL601	3	CL601/CF34-3A	84 1	79 5	77.0	75 1	73.6	67 4	88 4	84 2	81 5	78 9	75 9	67 6
CNA441	-	CONQUEST II/TPE331-8	74 9	72 6	70 7	69 4	68 2	64.2	84.1	80 4	78 1	76 2	74 3	68 6
CNA500	3	CIT 2/JT15D-4	86 7	84 0	79 9	77 8	76 2	70 2	85 5	81 3	78 5	76 1	73 6	66 6
COMJET	2	1985 BUSINESS JET	99 8	94 2	91 4	89 4	87 5	79 8	92 2	88 3	85 6	83 0	79 9	71 7
COMSEP	-	1985 1-ENG COMP	78 8	77.3	76 0	74 9	74 0	70 8	81 4	77 8	75 5	73 8	72 4	66 2
CONCRD	-	CONCORDE/OLY593	123 9	113 1	111 2	109 7	108 2	106 7	113 2	109 4	106 8	104 5	101 8	92 9
CVR580	-	CV580/ALL 501-D15	81 6	78 8	76 6	75 0	73 6	69 4	93 8	89 8	87 0	84 8	82 8	75 1
DC1010	3	DC10-10/CF6-6D	93.2	89 3	86 6	84 7	83 4	76 7	98 6	93 8	90 5	87 9	85 6	74 5
DC1030	3	DC10-30/CF6-50C2	92 9	89 7	87 7	85 9	84 3	77 5	98 7	94 0	90 7	87 8	84 4	74 4
DC1040	3	DC10-40/JT9D-20	95.1	90 8	88 1	86 4	84 7	77 4	98 0	93 2	89 9	87 3	84 8	75 4
DC3	-	DC3/R1820-86	94.1	91 9	88 2	85 0	83 7	80 5	97 9	94 0	91 5	89 1	86 6	80 3
DC6	-	DC6/R2800-CB17	99 1	94 5	92 8	91 4	90 2	86 0	101 3	97 4	94 8	92 3	89 5	82 1
DC820	1	DC-8-20/JT4A	103 7	100 3	96 9	92 6	90 8	82.8	108 2	102 9	99 4	96 8	94 5	86 6
DC850	1	DC8-50/JT3D-3B	101 2	97 2	94 6	92 4	90 2	82.1	111 4	106.5	103 0	99 8	96 3	82 0
DC860	1	DC8-60/JT3D-7	103 8	99 8	96 8	94.9	93 0	84.7	110.8	105 9	102 4	99 3	95 9	82 1
DC870	3	DC8-70/CFM56-2C-5	90 9	88 2	85 6	83.5	81 8	75.3	95.3	91 3	88 6	86 5	84 5	76 6
DC8QN	2	DC8-60/JT8D-7QN	102 3	98.3	95.9	94 0	92.3	85 6	102.1	97 3	93 9	91.2	89 0	81 5

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DC910	1	DC9-10/JT8D-7	95.4	92.6	90.5	88.7	86.9	80.3	100.1	94.9	91.4	88.3	85.0	77.1
DC930	1	DC9-30/JT8D-9	100.0	97.2	94.6	92.7	91.4	85.1	100.7	95.5	92.1	89.1	85.6	77.8
DC93LW	3	DC9-30/JT8D-9 with ABS Lig	93.9	91.3	88.6	86.5	85.2	78.2	93.5	89.5	86.9	84.3	80.9	73.6
DC950	2	DC9-50/JT8D-17	100.6	98.1	95.7	93.9	92.7	86.4	94.7	91.1	88.7	86.0	82.4	75.0
DC95HW	3	DC9-50/JT8D-17 with ABS H	94.1	91.8	89.1	87.2	86.0	78.9	92.5	88.5	85.8	82.7	78.1	69.6
DC9Q7	2	DC9-10/JT8D-7QN	94.5	91.7	89.7	87.8	86.1	79.5	93.3	89.7	87.2	84.7	81.4	74.1
DC9Q9	2	DC9-30/JT8D-9QN	99.0	96.3	93.8	91.9	90.6	84.4	94.3	90.7	88.2	85.7	82.1	74.9
DHC6	-	DASH 6/PT6A-27	81.3	79.2	77.5	76.0	74.8	66.4	93.3	89.6	87.3	85.3	82.9	76.6
DHC6QP	-	DASH 6/PT6A-27 Raisbeck (	81.0	79.7	79.1	78.8	78.3	75.1	84.7	82.2	79.5	76.5	72.8	62.6
DHC7	-	DASH 7/PT6A-50	73.8	71.3	69.4	66.8	64.5	60.8	80.8	77.4	74.6	72.3	70.3	63.8
DHC8	-	DASH 8-100/PW121	69.8	68.5	64.6	63.1	62.3	59.2	83.6	79.4	76.6	74.4	72.4	66.0
DHC830	-	DASH 8-300/PW123	70.0	68.7	67.6	65.6	63.9	60.7	82.8	78.5	75.7	73.5	71.6	65.3
EMB120	3	Embraer 120 ER	75.8	72.6	70.2	68.3	66.8	61.7	96.2	87.9	83.1	79.8	75.9	66.4
EMB145	3	Embraer 145 ER/Allison AE3	79.2	76.7	74.2	72.6	71.2	65.7	92.0	86.9	84.0	81.8	79.9	71.7
EMB14L	3	Embraer 145 LR	79.5	76.4	74.3	72.4	71	65.1	92.1	86.9	84	81.8	78.6	69.2
F10062	3	F100/TAY 620-15	86.1	83.6	81.8	80.2	78.8	73.6	90.5	86.9	84.6	82.2	78.9	71.4
F10065	3	F100/TAY 650-15	84.9	82.4	80.6	79.0	77.7	72.9	90.5	86.9	84.5	82.1	79.1	71.9
F16A	-	F-16A/PW-200	111.7	103.4	98.3	94.4	91.0	79.7	92.0	87.7	84.9	82.4	79.8	72.8
F16GE	-	F-16C/D/GE-110	102.2	94.1	89.1	85.4	82.4	74.1	89.4	84.6	81.4	78.5	75.5	67.5
F16PW0	-	F-16D/C/PW-220	111.0	102.7	97.5	93.6	90.2	80.7	89.7	85.0	81.9	79.1	76.3	68.6
F16PW9	-	F-16D/C/PW-229	112.4	104.4	99.4	95.8	92.7	83.7	93.7	89.5	86.5	83.9	81.3	74.5
F28MK2	2	F28-2000/RB183MK555	98.5	96.1	94.2	92.7	91.1	86.4	98.2	93.9	91.3	88.6	84.7	76.0
F28MK4	2	F28-4000/RB183MK555	95.8	93.1	91.1	89.7	88.1	82.8	97.5	93.6	91.2	88.5	84.5	75.6
F4C	-	F-4C/J79-GE-15	114.0	109.8	103.0	99.7	97.6	90.8	115.3	110.9	108.0	104.7	100.0	91.1
FAL20	2	FALCON 20/CF700-2D-2	95.4	92.0	88.4	85.8	83.9	76.7	99.2	94.2	90.6	87.6	84.5	74.0
GASEPF	-	1985 1-ENG FP PROP	76.2	74.4	73.2	72.1	71.2	68.1	78.1	74.5	72.2	70.5	69.1	63.4
GASEPV	-	1985 1-ENG VP PROP	81.4	79.7	78.2	77.1	76.2	72.8	85.8	82.2	79.9	78.2	76.9	69.0
GIIB	2	GIIB/SPEY MK511-8	107.3	101.1	98.6	96.8	95.2	88.2	97.5	93.5	90.8	88.0	84.8	76.3
GIV	3	GIV/TAY 611	89.0	83.7	81.5	79.5	77.9	72.2	87.9	84.2	81.9	79.6	76.8	70.2
HS748A	-	HS748/DART MK532-2	89.7	86.4	84.1	82.8	81.6	77.7	98.0	92.7	88.7	85.2	81.3	70.4
IA1125	3	ASTRA 1125/TFE731-3A	90.3	86.9	81.8	80.0	78.2	71.8	84.8	80.9	78.2	75.7	73.1	64.8
KC135	-	KC135A/J57-P-59W	124.2	122.5	121.6	118.1	115.0	107.7	114.9	110.5	107.6	104.4	100.2	90.2
KC135B	-	KC135B/JT3D-7	112.1	106.5	103.2	101.0	99.2	90.5	110.1	105.3	101.7	98.2	94.0	81.3
KC135R	-	KC135R/CFM56-2B-1	101.4	96.5	93.6	91.6	90.1	83.2	97.8	93.7	91.0	88.4	85.4	78.0

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L1011	3	L1011/RB211-22B	94 8	90 8	88 0	85 9	84 5	77 9	100 3	95 7	92 5	89 7	86 7	76 4
L10115	3	L1011-500/RB211-224B	93 9	90 3	87 8	85 9	84 3	77.4	100 5	95 8	92 7	90 1	87 4	76 6
L188	-	L188C/ALL 501-D13	84 6	81 7	79 5	77 9	76 5	72 2	96 4	92 4	89 6	87 4	85 2	78 1
LEAR25	2	LEAR25/CJ610-8	104 6	99 3	96 4	94 4	92 3	83 9	99 8	95 9	93 3	90 6	87 3	76 0
LEAR35	3	LEAR36/TFE731-2	90 6	85 0	82 2	80 2	78 3	71 0	88 3	83 9	80 8	78 1	75 1	68 2
MD11GE	3	MD-11/CF6-80C2D1F	88 9	85 8	83 9	82 0	80 5	74 4	95 0	91 2	89 5	87 8	85 5	79 0
MD11PW	3	MD-11/PW 4460	90 3	86 0	83 9	81 7	80 1	74 1	97 8	93 6	91 1	89 0	86 9	80 6
MD81	3	MD-81/JT8D-209	93 5	90 0	87 7	86 0	84 3	78 4	90.0	86 8	84 6	82 4	79 6	71 7
MD82	3	MD-82/JT8D-217A	93 3	90 6	88 3	86 4	84 9	78 5	90 1	86 8	84 7	82 5	79 7	71 9
MD83	3	MD-83/JT8D-219	95 3	92 0	89 6	87 7	86 2	79 7	90.4	87 1	85 0	82 8	79 9	72 0
MD9025	3	MD-90/V2525-D5	87 5	84 0	81.4	79 4	77 9	72.4	91 6	87 5	84 8	82 6	80 7	75 2
MD9028	3	MD-90/V2528-D5	86 2	83.4	80 9	79 2	77.9	72.1	91.6	87 5	84 8	82 6	80 7	75 2
MU3001	3	MU300-10/JT15D-4	91 3	88 4	84 7	83 0	81 6	76 1	87 2	82 9	79 9	76 9	73 0	65 1
SABR80	2	NA SABRELINER 80	95 4	92 0	88 4	85 8	83 9	76 7	99 2	94 2	90 6	87 6	84 5	74 0
SD330	-	SD330/PT6A-45AR	82 8	78 6	76 9	75.5	74 3	70 7	87 5	83 9	81 6	79 9	78 4	73 4
SF340	-	SF340B/CT7-9B	76 7	74 7	73 3	72 1	71 3	67 9	86 3	82 5	80 0	78 0	76 1	70 5

Glossary

Air carrier	Commercial airline an operator which is certified in accordance with Federal Aviation Regulation (FAR) parts 121 and 127
ATCT	Air Traffic Control Tower central operations tower in the air traffic control system that provides safe, expeditious movement of air traffic.
Aircraft type	Particular airframe and engine. In INM, a 6-character code referring to a particular type of aircraft.
Algorithm	A series of mathematical steps in a calculation process.
ALP	Airport Layout Plan: source of such information as runway layout and endpoint coordinates, airfield elevation, displaced thresholds, etc.
ANOMS	Aircraft Noise and Operations Monitoring System HMMH proprietary software system.
ARTS	Automated Radar Terminal System: source of airport radar data.
CAD	Computer Aided Design.
Case	A particular scenario can be one of several in an airport noise study.
Centroid	The geographic center of a region such as a census block.
Census block	The smallest community subdivision used by the U.S. Census Bureau; defined by geographical boundaries
CNEL	Community Noise Equivalent Level: a computed average of noise over a 24-hour period, with events occurring between 7 pm and 10 pm penalized by 4.77 dB, events between 10 pm and 7 am penalized by 10 dB.
Database	A collection of related data, usually stored in column and row format.
dB	Decibel, the fundamental unit of environmental noise measurement.
dBA	A-weighted decibel
DBF	Database file.
Dialog box	A standard Windows program user interface; in INM, a means for creating or editing database records.
Displaced threshold	A takeoff or landing threshold that is located at a point on the runway other than the designated beginning of the runway.

DNL	Day Night Sound Level. a computed average of noise over a 24-hour period, with events occurring between 10 pm and 7 am penalized by 10 dB
DOS	Disk Operating System.
EPNL	Effective Perceived Tone-Corrected Noise Level.
FAA	United States Federal Aviation Administration.
FBO	Fixed Base Operator: a provider of services to users of an airport.
Field	Name of a column of data in a database file.
Fleet mix	Collection of aircraft types operating at an airport or owned by a particular air carrier. Term may also refer to yearly operational activity at an airport - which includes aircraft types and activity level, with operations separated by departure stage length and time of day.
FLIGHT	HMMH proprietary software designed to sort and analyzes ARTS data.
Flight track	Depiction of aircraft departure or arrival path over the ground.
General aviation	That portion of civil aviation that includes all facets except commercial air carriers and military aircraft.
Glide slope	Vertical guidance by reference to airborne instruments during instrument approaches such as an ILS, or for the visual portion of an instrument approach and landing; usually 3 or 5 degrees.
Grid	An array of points.
Ground track	Projection of flight track onto the ground.
INM	Integrated Noise Model developed by the FAA
Irregular grid	The set of points produced by the INM during noise contour calculation. Created by recursive subdivisions of contour grid.
Knots	Nautical miles per hour (a unit of speed).
Location points	Points defined in latitude, longitude coordinates representing particular items, such as noise-sensitive locations or navaids.
Metrics	Standards of measurement
Model track	A flight track in an INM study that is used in noise calculations.
Navaids	Electronic navigational aids for aircraft, located on the ground

NMPlot	Software (developed by the U S Air Force) accessed by INM 5 0/5 1 for constructing noise contours from grid files
Noise contour	Computer-generated lines connecting points of equal noise exposure, usually depicted in five-decibel increments
Noise curves	Noise vs Distance data for specified engine-thrust settings
Noise stage	(See stage certification)
OAG	Official Airline Guide.
Operation	An aircraft flight; in INM, defined as an approach, departure, touch-and-go, or over flight.
PC	Personal computer (IBM compatible).
Performance profiles	Collection of data tables that describe aircraft performance. speed vs. distance, altitude vs. distance, thrust vs. distance.
Population points	Set of census block centroids within user-defined window.
PREPROC	Accessory program to INM 5 0/5.1, used to translate data into INM-readable formats
Radar track	Aircraft flight path defined by radar returns; in INM 5 0/5.1, used to derive model tracks
Record	Row entry in a database file, with one data item in each field.
Refinement	In INM, number of repetitions of grid subdivision algorithm
SEL	Sound Exposure Level.
Spreadsheet	Computer software with column-and-row structure
Slant distance	Distance from an aircraft to a point on the ground. Hypotenuse of the right triangle formed by aircraft altitude and perpendicular distance of point from ground track.
Stage certification	Noise classification number (1, 2, or 3) assigned to a particular aircraft type by Federal Aviation Regulations (FAR) Part 36. Noisiest aircraft are Stage 1
Stage length	Trip distance (for non-stop flight).
Study	In INM, a set of cases for noise analysis that share certain input data, such as runway and flight track geometry.
Substitution aircraft	Equivalent aircraft type (for purposes of noise modeling).

Terrain feature touch-and-go	In INM, the process by which the ground elevations surrounding the airport are taken into account in noise calculations training pattern operation, consisting of a landing and takeoff cycle, and (possibly) repeated pattern revolutions.
Tolerance	In INM, contour grid precision parameter
Window	A particular screen display in a Windows program.
Windows	A graphical operating environment for running programs and managing files on a PC.
XY coordinates	Set of numbers specifying location in reference to the airport origin.

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