INM - Integrated Noise Model Basics

CEE 4674 - Airport Planning and Design

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Basics on INM

- Developed by FAA Office of Energy and Environment and EPA
- The initial versions of INM was developed in FORTRAN and ported to the PC in 1982
- Newest version is 7.0 (runs on Windows XP or Vista OS)
- The model includes a good database (101 aircraft currently) to analyze civilian airports
- A similar model has been developed by the human factors group at Wright Patterson AFB to predict noise contours around military bases (NOISEMAP 6.1)

Justification for INM

- After 1969 every transportation project (including airport upgrades and plans) require a detailed environmental study
- The only way to convey information to communities around an airport is to compute potential noise levels before constructing a facility
- Noise prediction is a tedious process for real airports as there are too many aircraft and tracks that need to be analyzed in determining the noise at a point on the ground

Inputs to INM

- Airport characteristics (runways, orientation, etc.)
- Approach and departure profiles
  - Procedural (aerodynamic based profiles)
  - Fixed point profiles
- Flight tracks
  - Approach
  - Departure
  - Touch-and-go
  - Circling
  - Overflights

Inputs to INM

- Flight operations
  - + Numbers of aircraft assigned to each track
  - + Percent aircraft assigned to each track
  - + Runup operations (engine test operations)
- Noise Metric
  - + Select among DNL, CNEL, NEF, TNEL, and 12 others.

INM Output

- Noise contours (contours of equal values of a noise metric like DNL)
- Complex metric population point calculations (i.e. DNL level at a specific city block)
- Population living within a given complex noise metric (i.e., how many people live within DNL 55 contour)

Detailed Procedures for INM

1) Open a New Case Study from the File menu

2) Select the airport in question in the Setup Window

3) Verify all runway data (including altitudes and displaced thresholds)

4) Go to the Aircraft Window to select all the aircraft to be modeled in your case study

5) Apply aircraft substitutions as needed

6) Select the noise metric to be used in the computational procedure (from Setup - Metrics menu)

Procedures (II)

7) Add a Case from Setup-Cases menu

8) Define aircraft approach and departure tracks from the Tracks menu (select Input Graphics)

9) Define aircraft operations using the Acft menu (select Flight Ops...)

10) Run the case study using the Run menu

- Define the Grid Setup and Grid parameters used

11) Under Run Options (Run menu) select the noise metric desired and commit record

Procedures (III)

12) To view the output create an output scenario from the Output menu (select Output Setup)

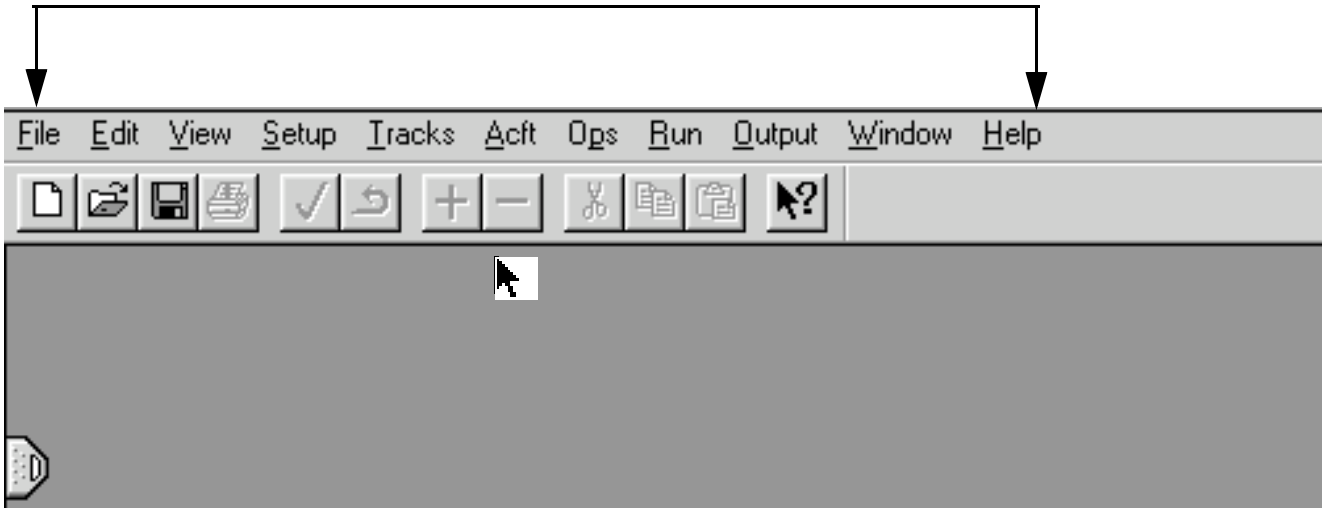
- If your plot is incomplete increase the grid size and modify the grid coordinates appropriately to increase the siae of the grid

NOTE: When entering data in INM always COMMIT records otherwise data is not saved

INM 7 Menus

- Like many Windows applications INM has many pull-down menus to execute tasks (shown below)
- Each menu will be explained in detail later

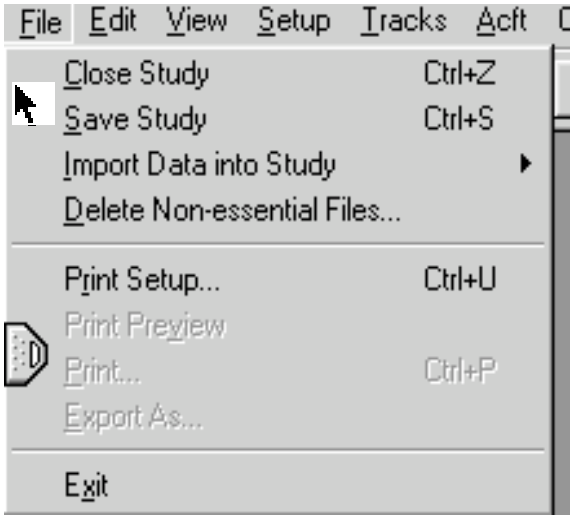
Pull-down menus



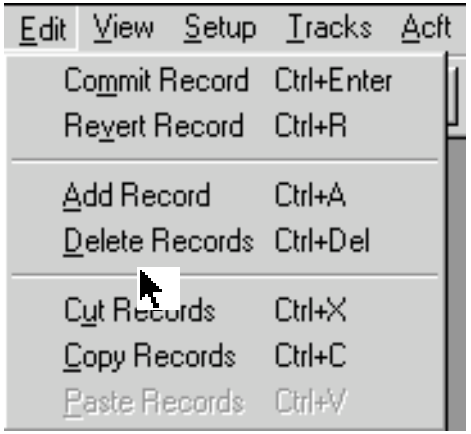
INM 7.0 Menus

- **File** and **Edit** pull-down menus
- Use **File** to create new studies, save them and import/ export operations
- Use **Edit** to add, commit, cut and paste records

File



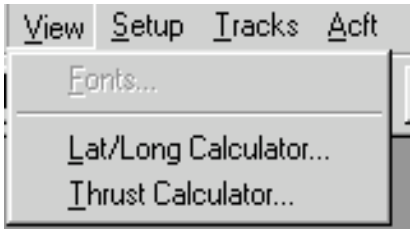
Edit



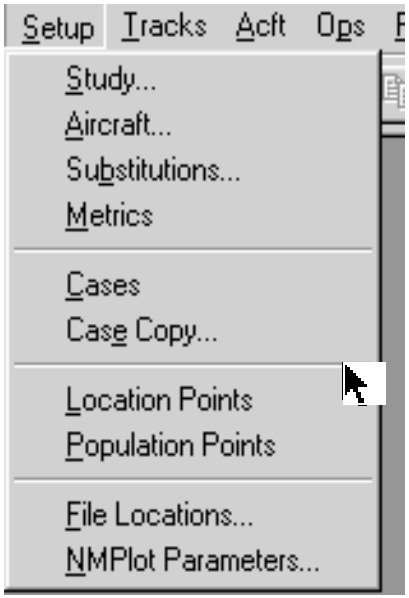
INM 7.0 Menus

- Use View to calculate distances and compute thrust
- Use Setup to define aircraft, noise metrics,cases, etc.

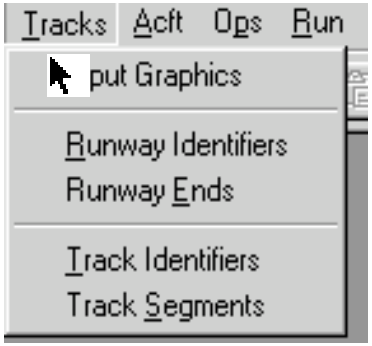
View



Setup

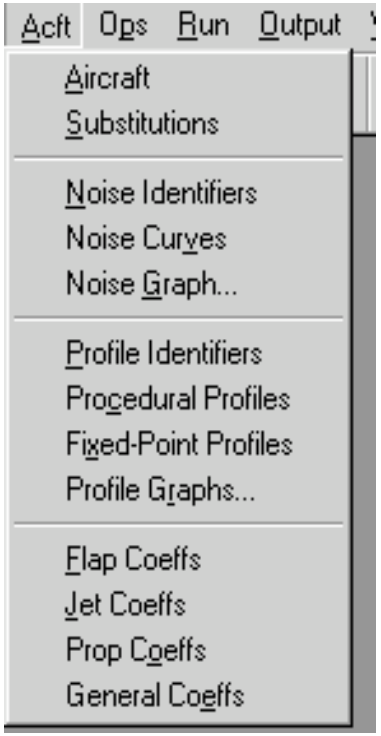


Tracks



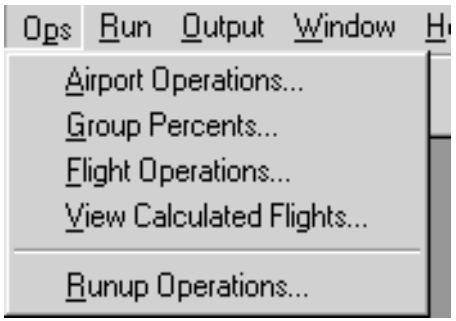
INM 7.0 Menus (ACFT, OPS, RUN)

Define all aircraft and Noise-Distance-Power curves in INM. Also define flight operations (**Ops** Menu)



Acft

Ops

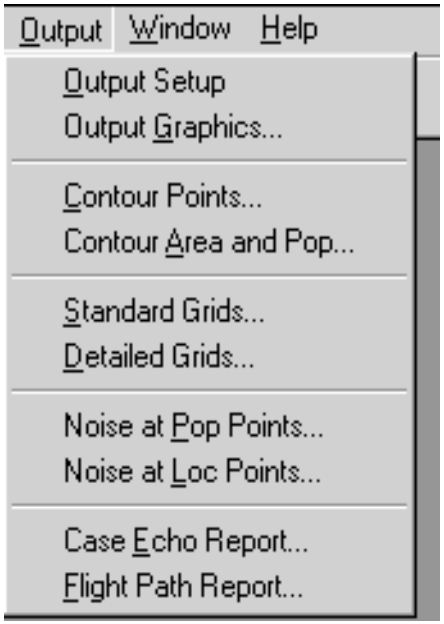


Run

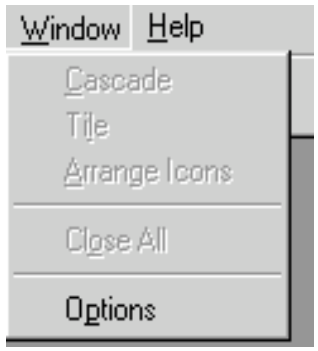
INM 6.1 Menus

- **Output** - use it to prepare output parameters including output setup, output graphics window options, contour points, and flight path reports

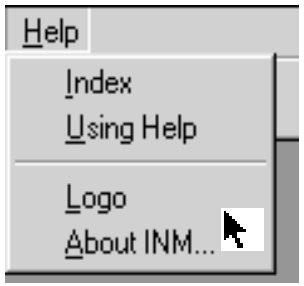
Output



Window

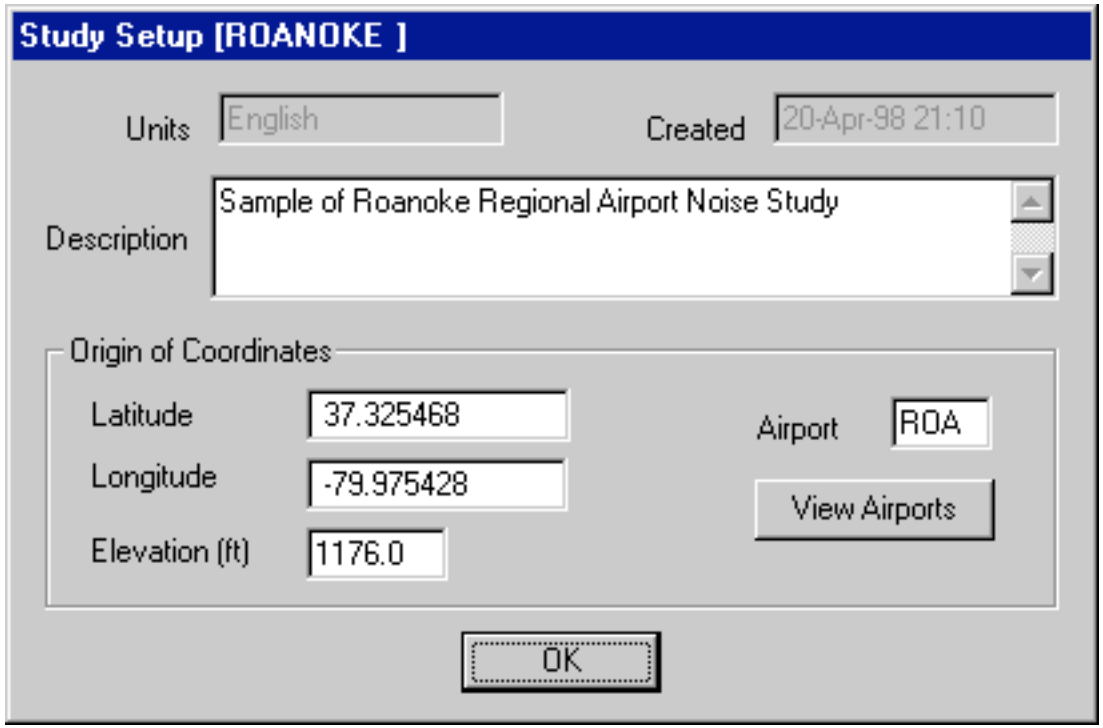


Help



Study Screen

The study screen allows you to find predefined airports



What if the Airport is not Contained in INM Database?

- Define manually the runway end points
- INM will do the rest
- Runway ends are defined as latitude and longitude points
- Always check the latitute and longitude points of the runway selected. INM could have errors and thus it is your responsibility to check the inputs.

Defining Tracks in INM

Three ways to do it:

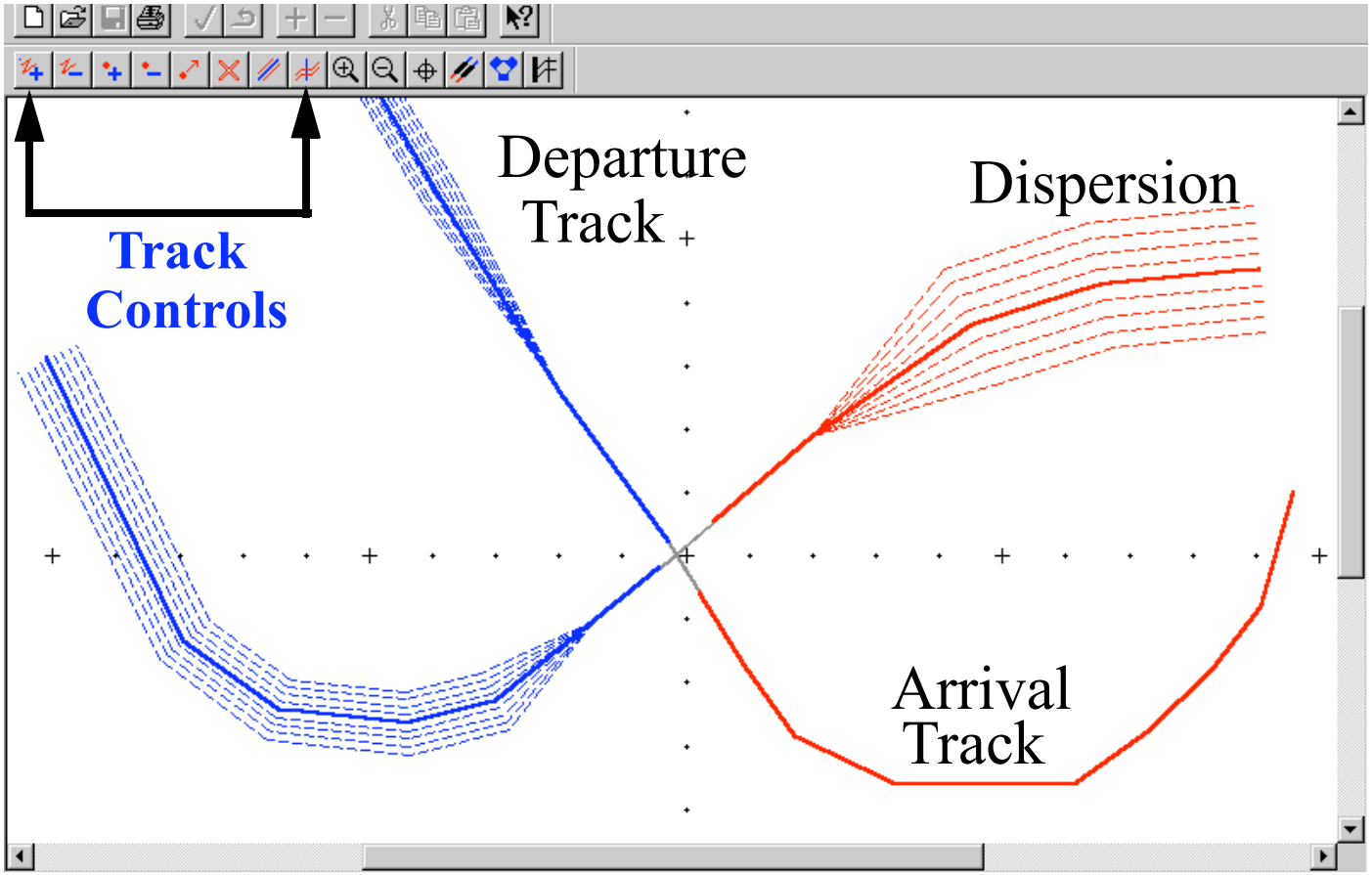
- Interactive tracks (called P-tracks)
- Vector tracks (V-tracks)
- Tracks using radar data

Interactive tracks are defined using the computer mouse and only represent straight line segments. Use vector tracks are defined by arcs and straight line segments

Only interactive (p-tracks) can be dispersed to show more realistic flight path deviations.

Interactive Tracks (P-tracks)

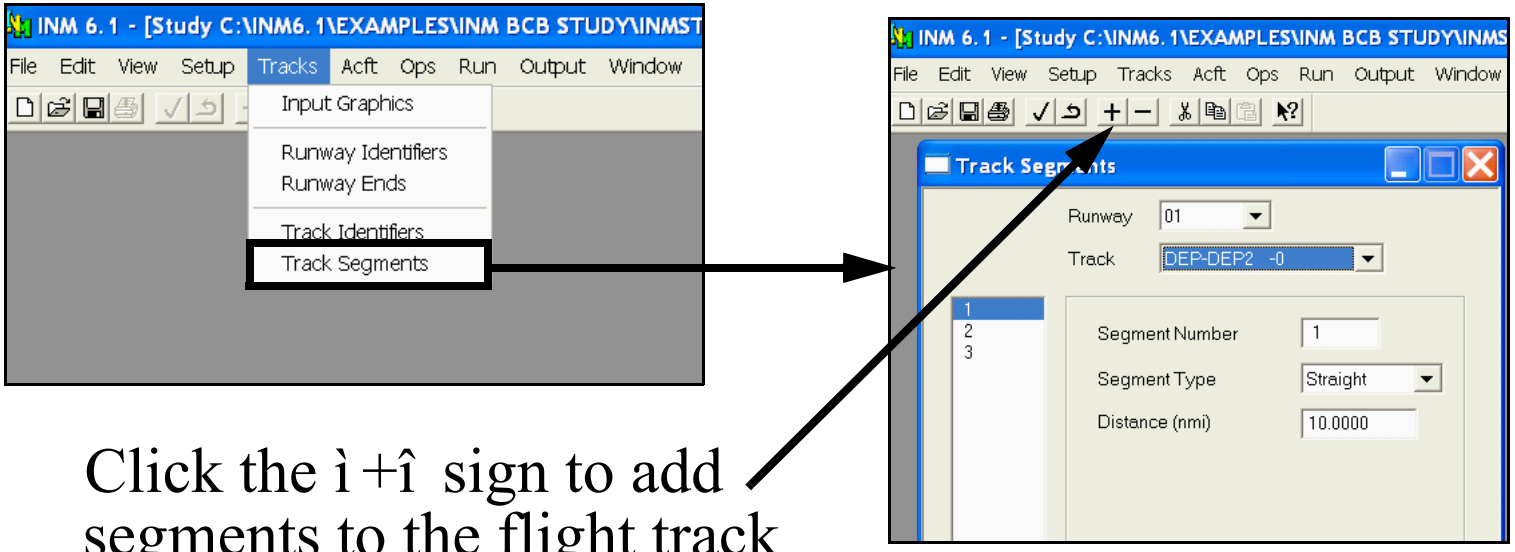
Tracks can be defined interactively using the mouse



Vector Tracks (V-Tracks)

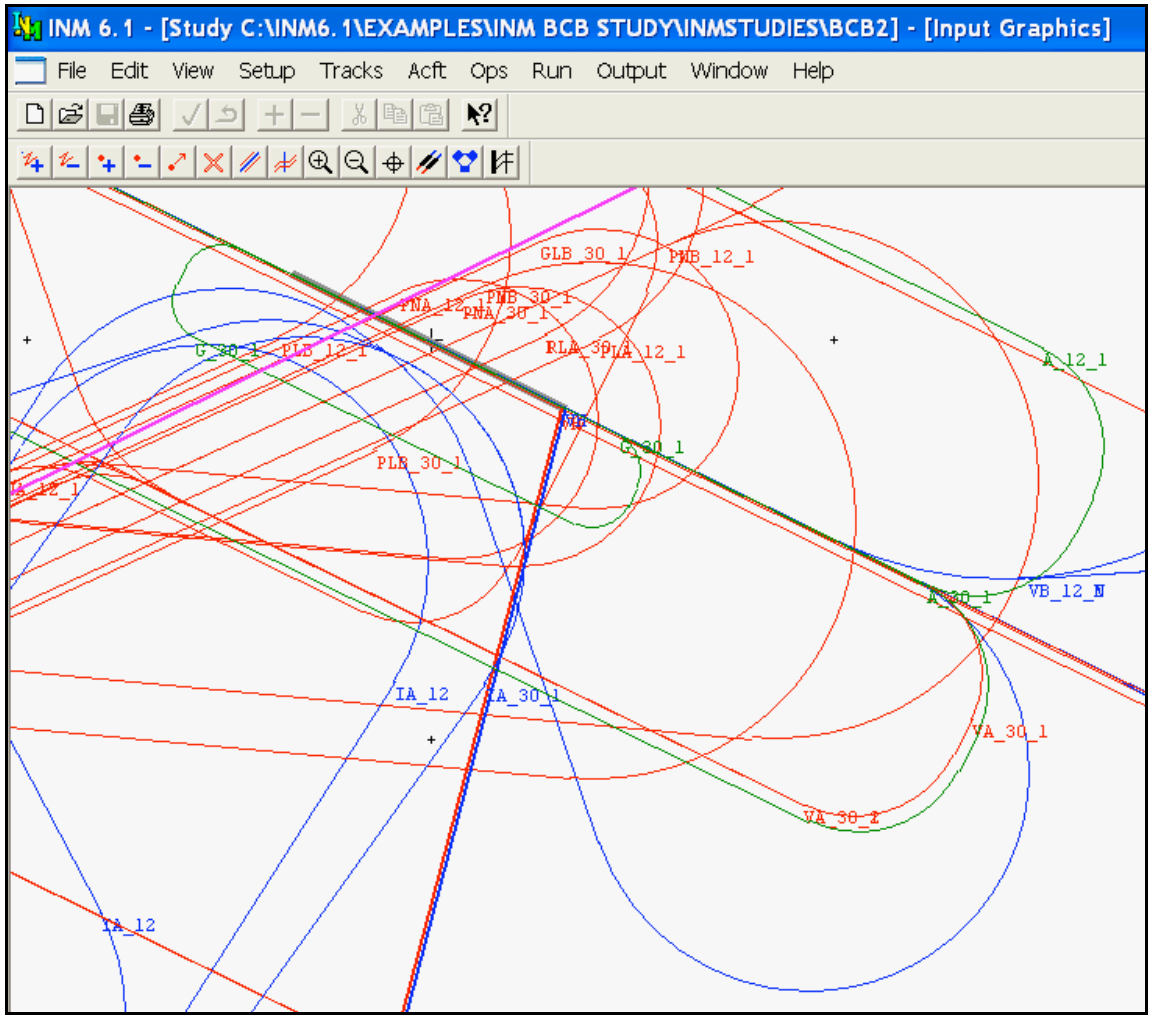
Defined by a combination of straight line and arc segments

To define a V-track select the ì Track Segmentsî from ì Tracksî pull-down menu



Click the ì +î sign to add segments to the flight track

Sample V-Tracks for BCB Airport



Summary of Tracks in INM

Both procedures are acceptable in practice

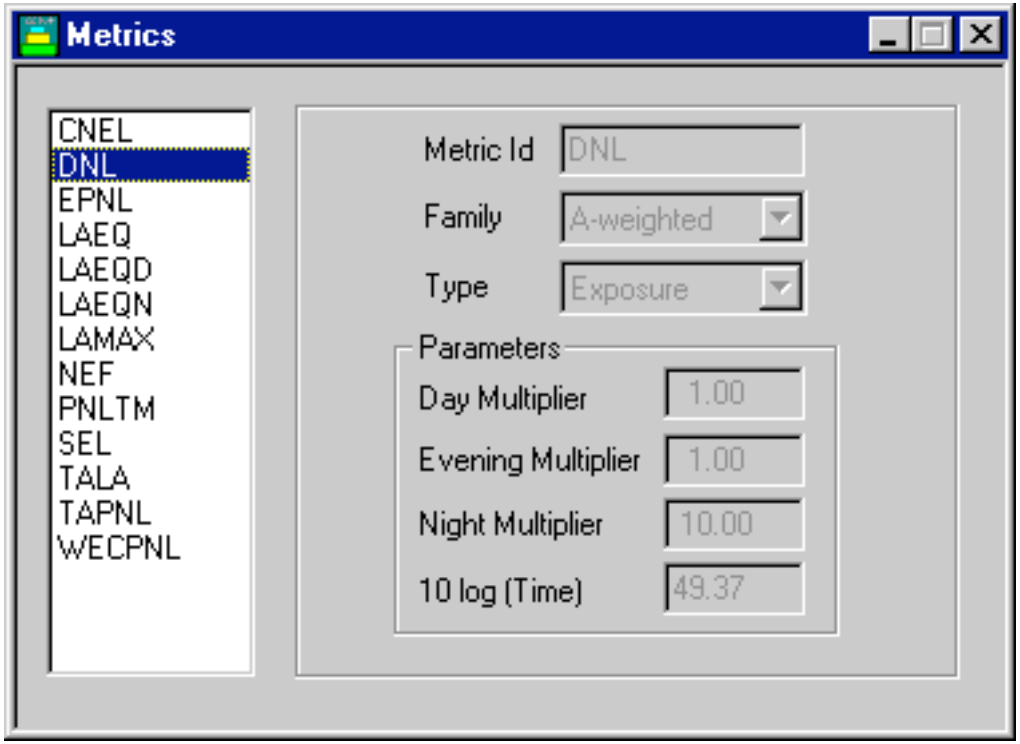
Interactive tracks can be dispersed to show more realistic flight paths

Interactive tracks require many straight segments to represent a realistic aircraft turn

Vector tracks generally produce ì better lookingî contours (not necessarily more accurate)

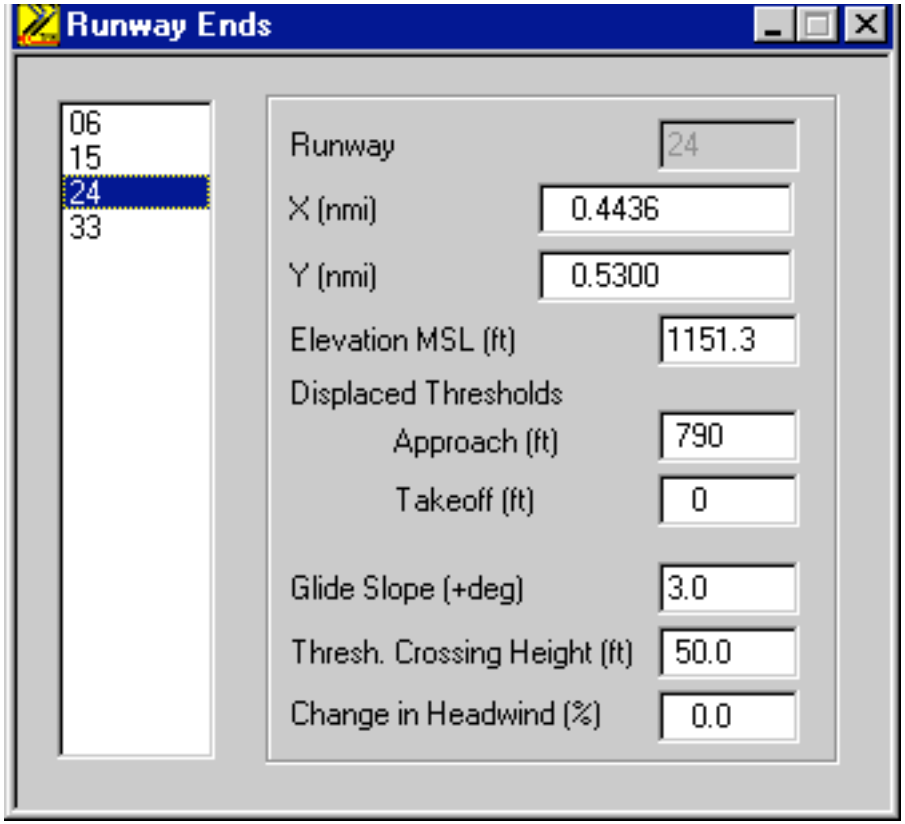
Select the Analysis to be Carried Out

INM 7.0 has more than a dozen noise metrics built-in



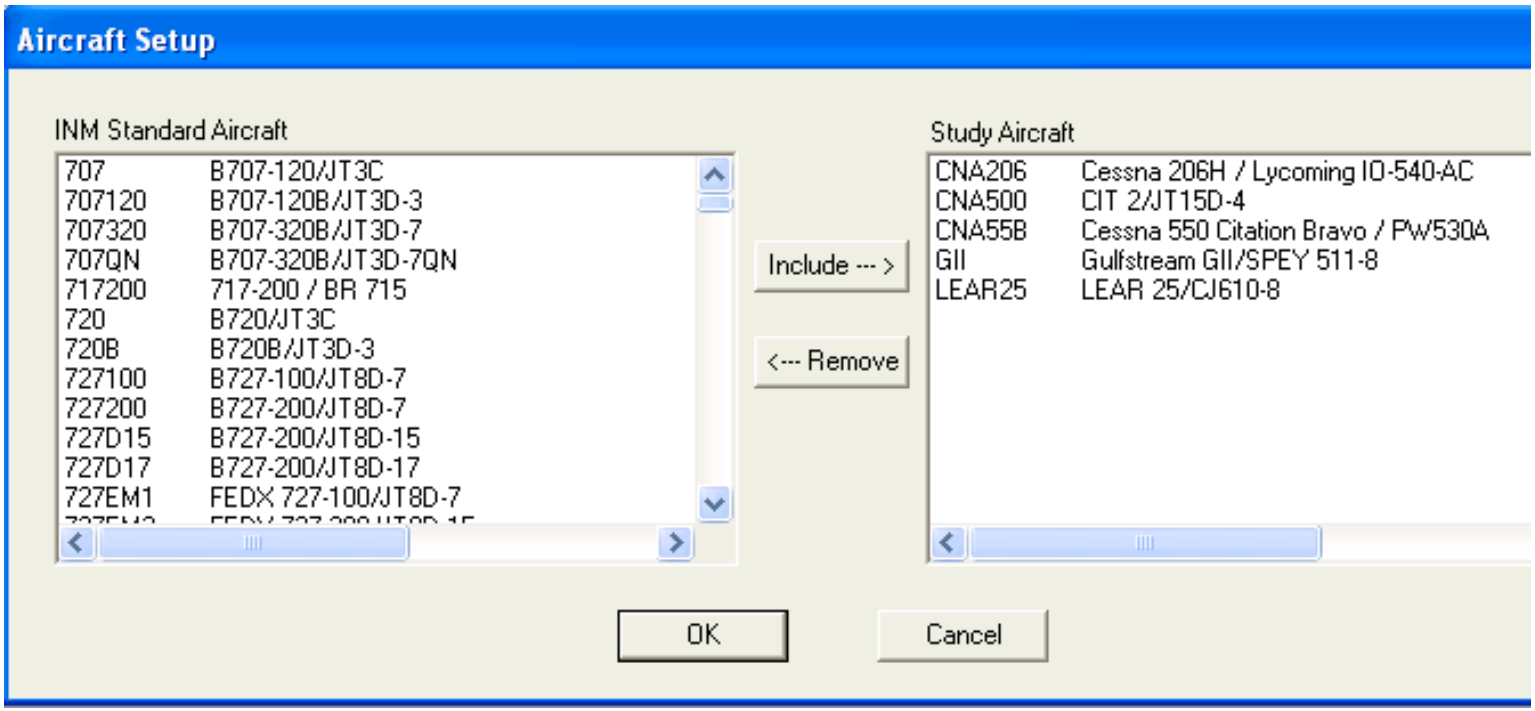
Runway End Definition

Once an airport is defined runways can be edited interactively



Aircraft Definition Window

This window allows you to define the aircraft to be included in your study



Noise Cases

INM allows you to define various cases in a single run

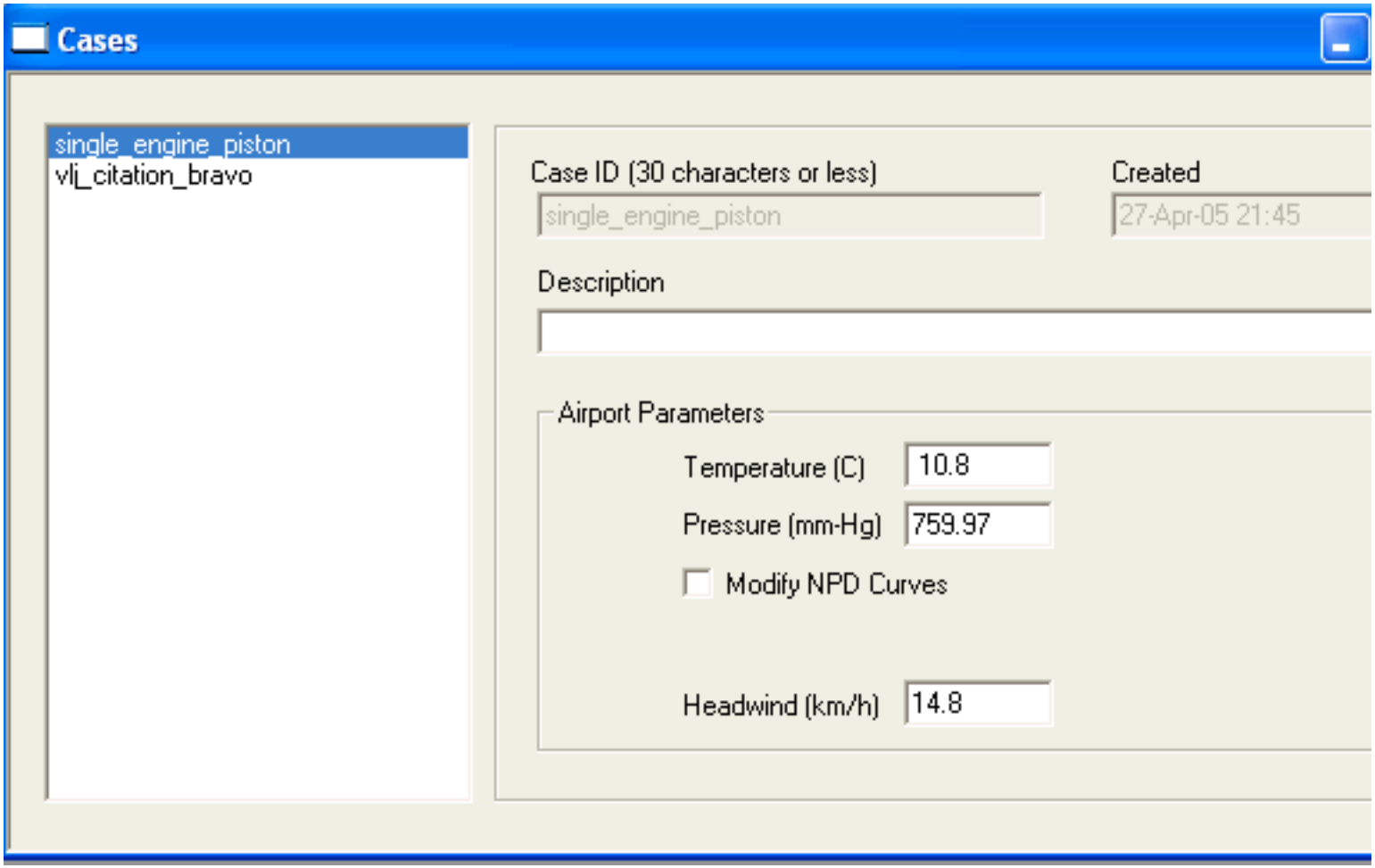
Cases can be defined to understand individual noise contours of specific aircraft modeled

For example, below we show two cases defined as:

+ vlj_citation_bravo
+ single_engine_piston

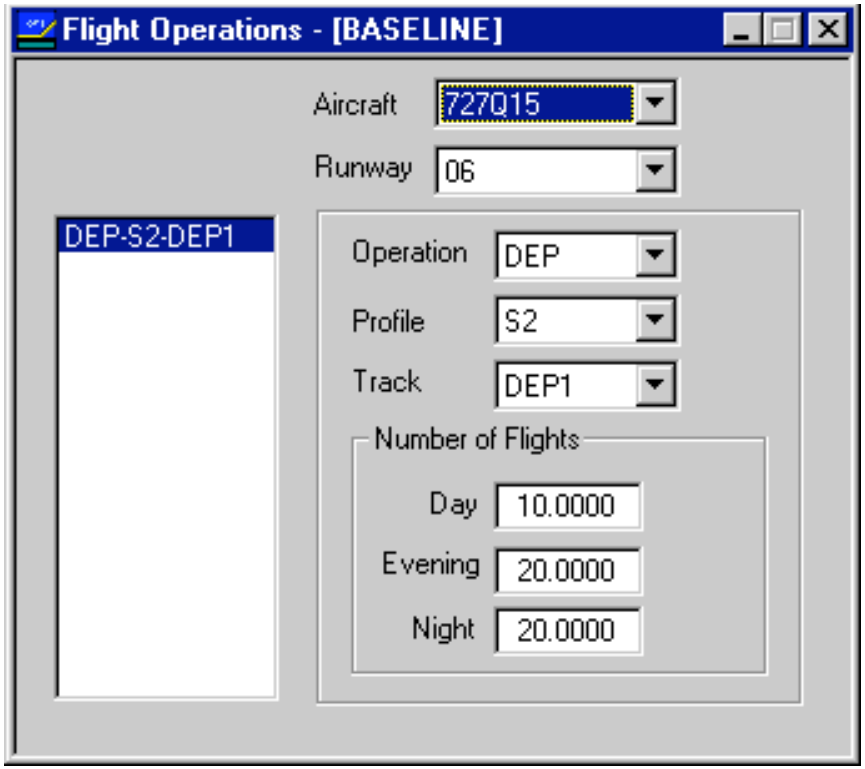
- Each case represents two aircraft populations that will be executed individually
- Each case should have a corresponding output

Cases Window



Aircraft Operations Windows

Define aircraft operations in the flight operations window



Flight Operations (View)

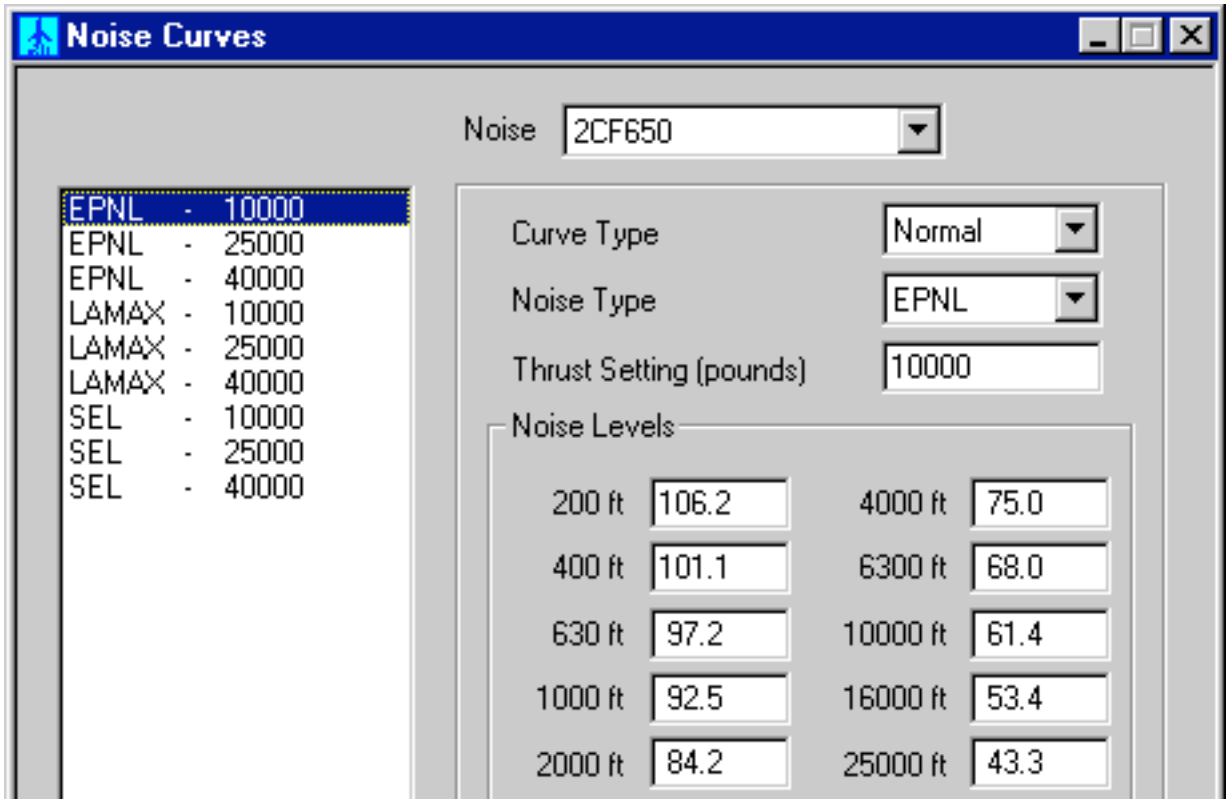
Flight operations can be viewed as a table

Case Operations - [BASELINE]

ACFT	OP	PF	S	RWY	TRACK	SUB	GROUP	DAY	EVE	NIGHT
727Q15	A	S	1	24	APP1	0	COM	27.3200	27.3200	27.3200
727Q15	A	S	1	24	APP1	1	COM	21.8800	21.8800	21.8800
727Q15	A	S	1	24	APP1	2	COM	21.8800	21.8800	21.8800
727Q15	A	S	1	24	APP1	3	COM	10.9400	10.9400	10.9400
727Q15	A	S	1	24	APP1	4	COM	10.9400	10.9400	10.9400
727Q15	A	S	1	24	APP1	5	COM	3.1300	3.1300	3.1300
727Q15	A	S	1	24	APP1	6	COM	3.1300	3.1300	3.1300
727Q15	A	S	1	24	APP1	7	COM	0.3900	0.3900	0.3900
727Q15	A	S	1	24	APP1	8	COM	0.3900	0.3900	0.3900
727Q15	A	S	1	33	APP2	0	COM	100.0000	100.0000	100.0000
727Q15	D	S	2	06	DEP1	0	COM	2.7320	5.4640	5.4640
727Q15	D	S	2	06	DEP1	1	COM	2.1880	4.3760	4.3760
727Q15	D	S	2	06	DEP1	2	COM	2.1880	4.3760	4.3760
727Q15	D	S	2	06	DEP1	3	COM	1.0940	2.1880	2.1880
727Q15	D	S	2	06	DEP1	4	COM	1.0940	2.1880	2.1880
727Q15	D	S	2	06	DEP1	5	COM	0.3130	0.6260	0.6260
727Q15	D	S	2	06	DEP1	6	COM	0.3130	0.6260	0.6260
727Q15	D	S	2	06	DEP1	7	COM	0.0390	0.0780	0.0780
727Q15	D	S	2	06	DEP1	8	COM	0.0390	0.0780	0.0780

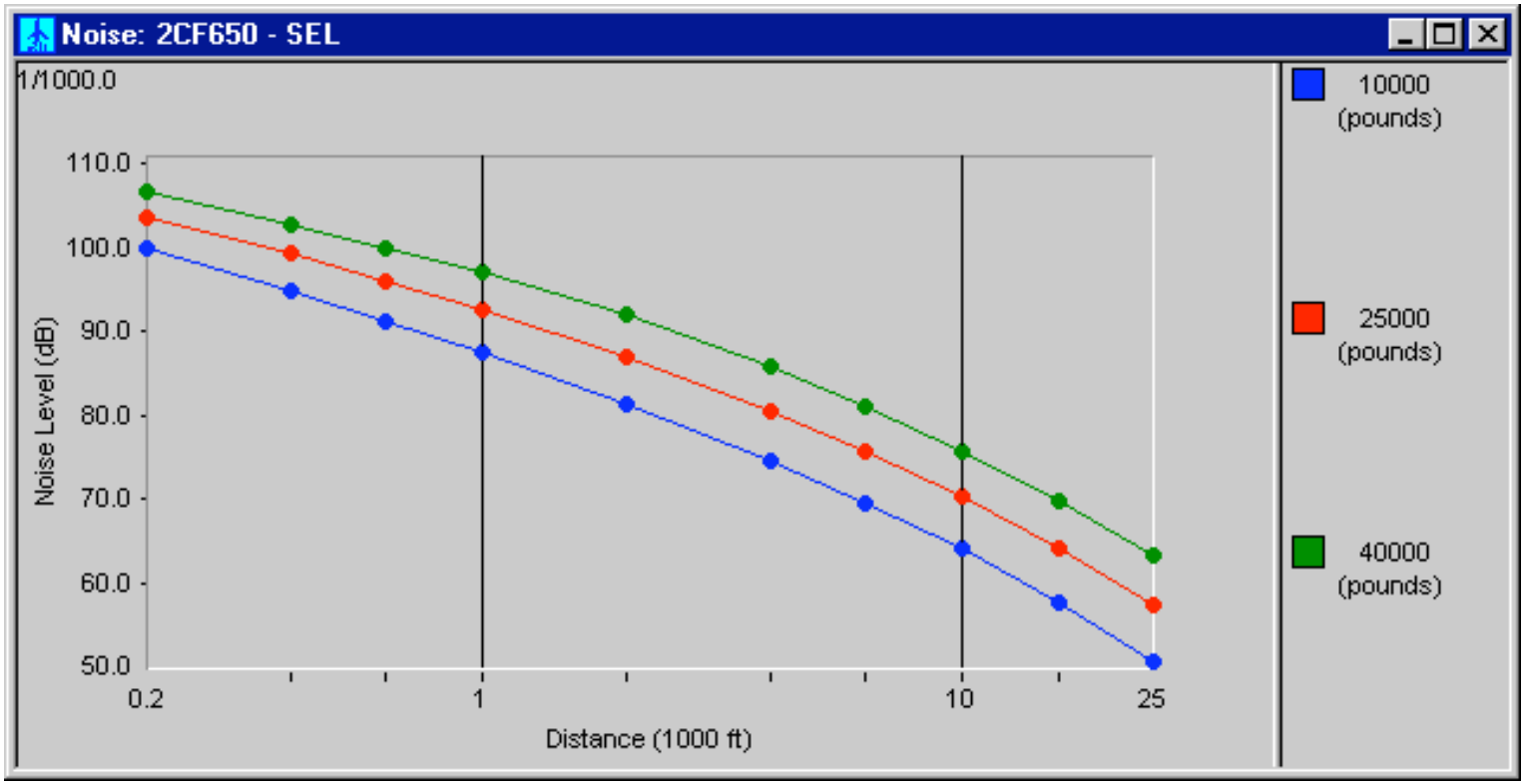
Noise Groups

Define explicit groups of aircraft in the modeling process



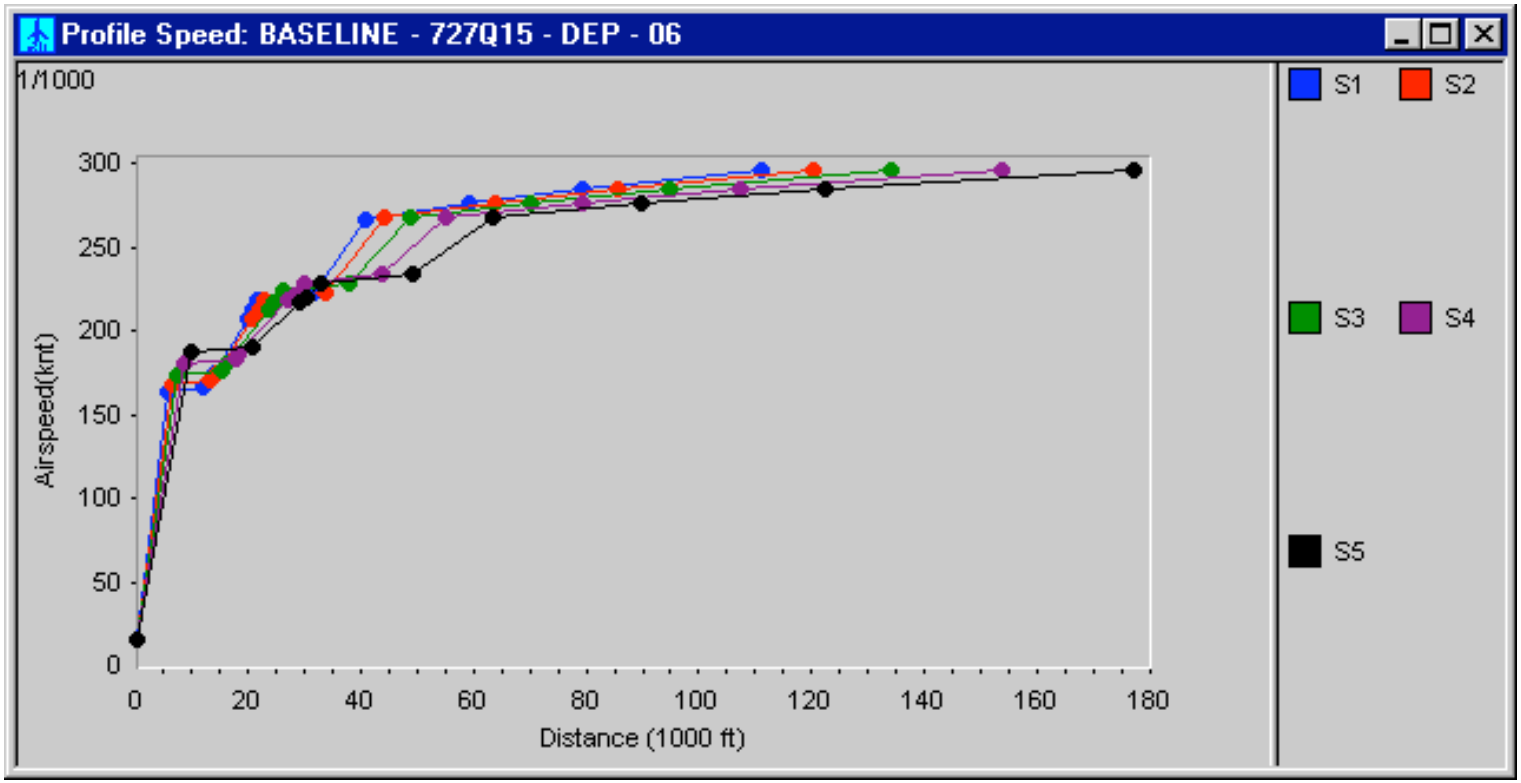
Noise Curves

Noise curves provide a graphical output of EPNL or SEL metrics (single flyover)



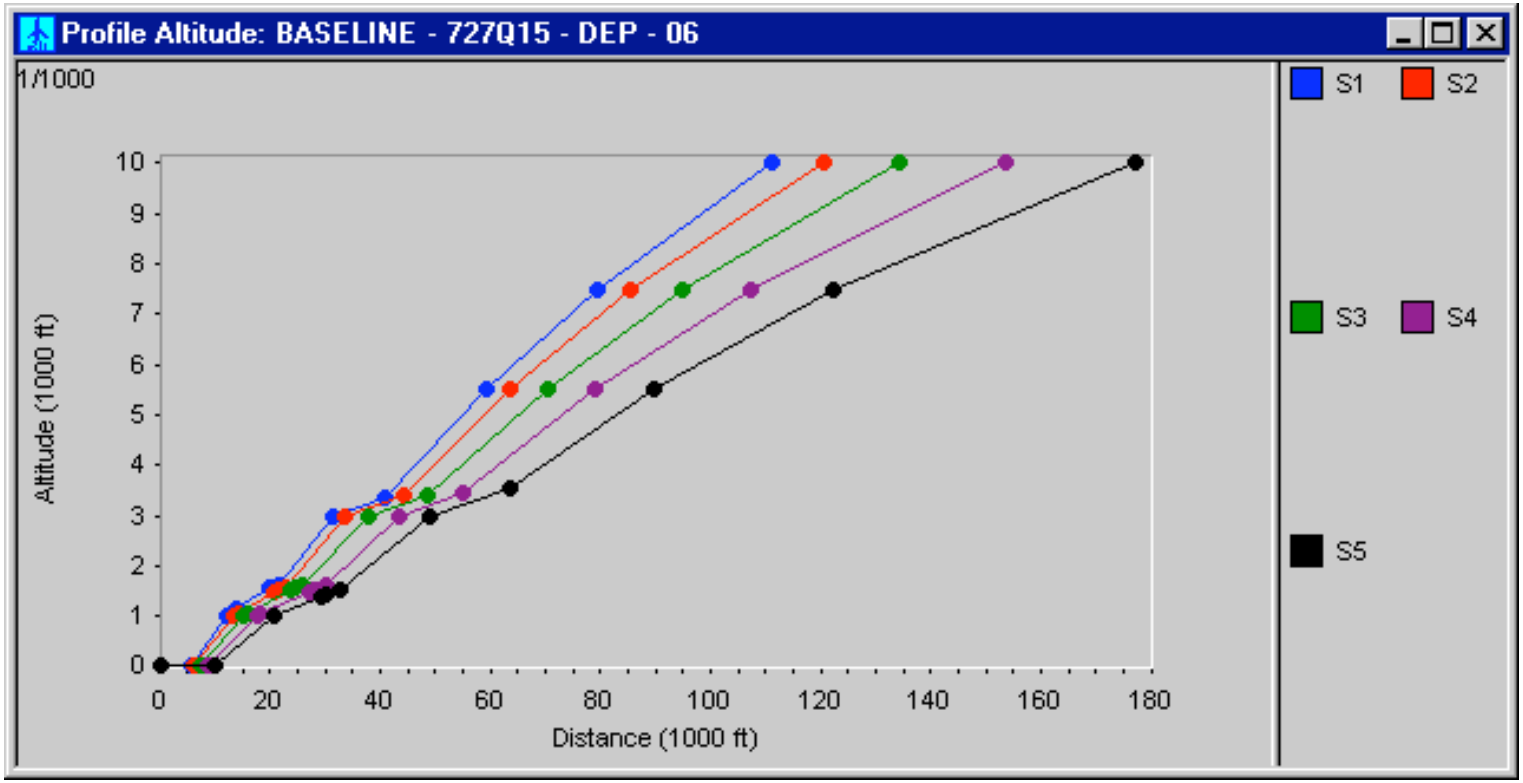
Aircraft Vertical Profiles

Aircraft profiles can be viewed interactively



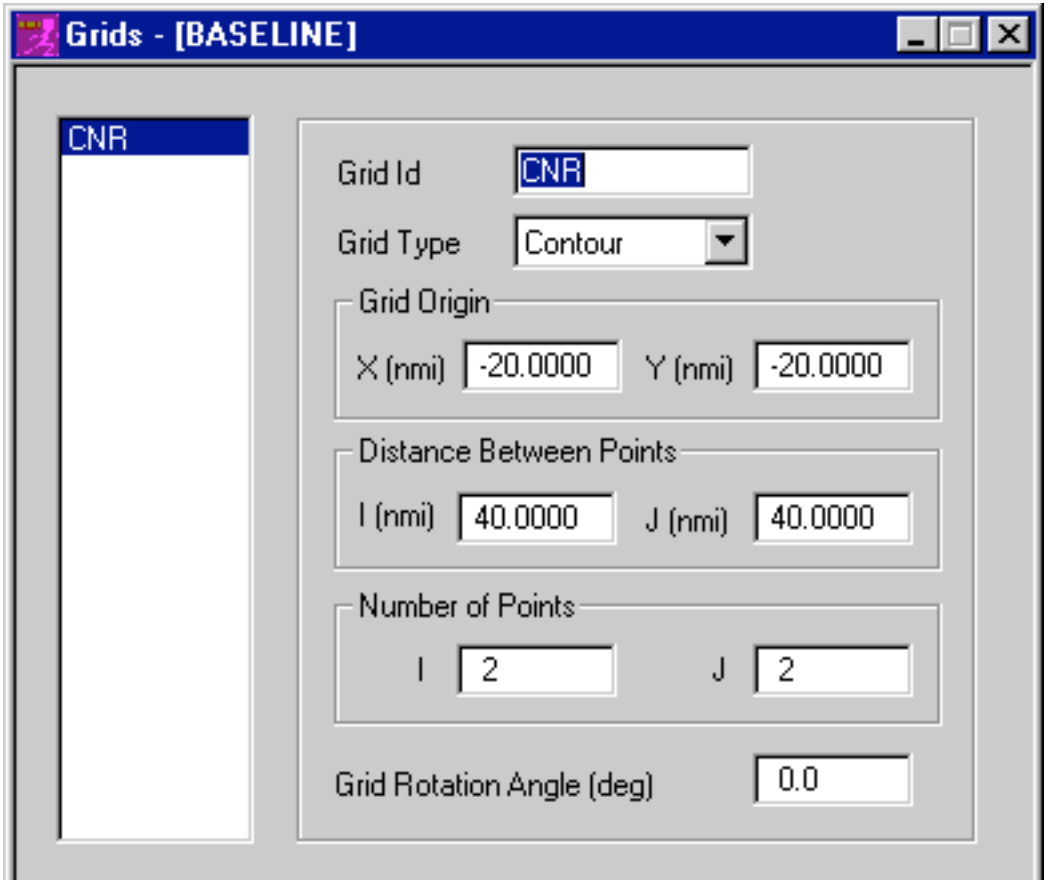
Another Aircraft Profile Sample

This plot shows distance vs. altitude flown with B727



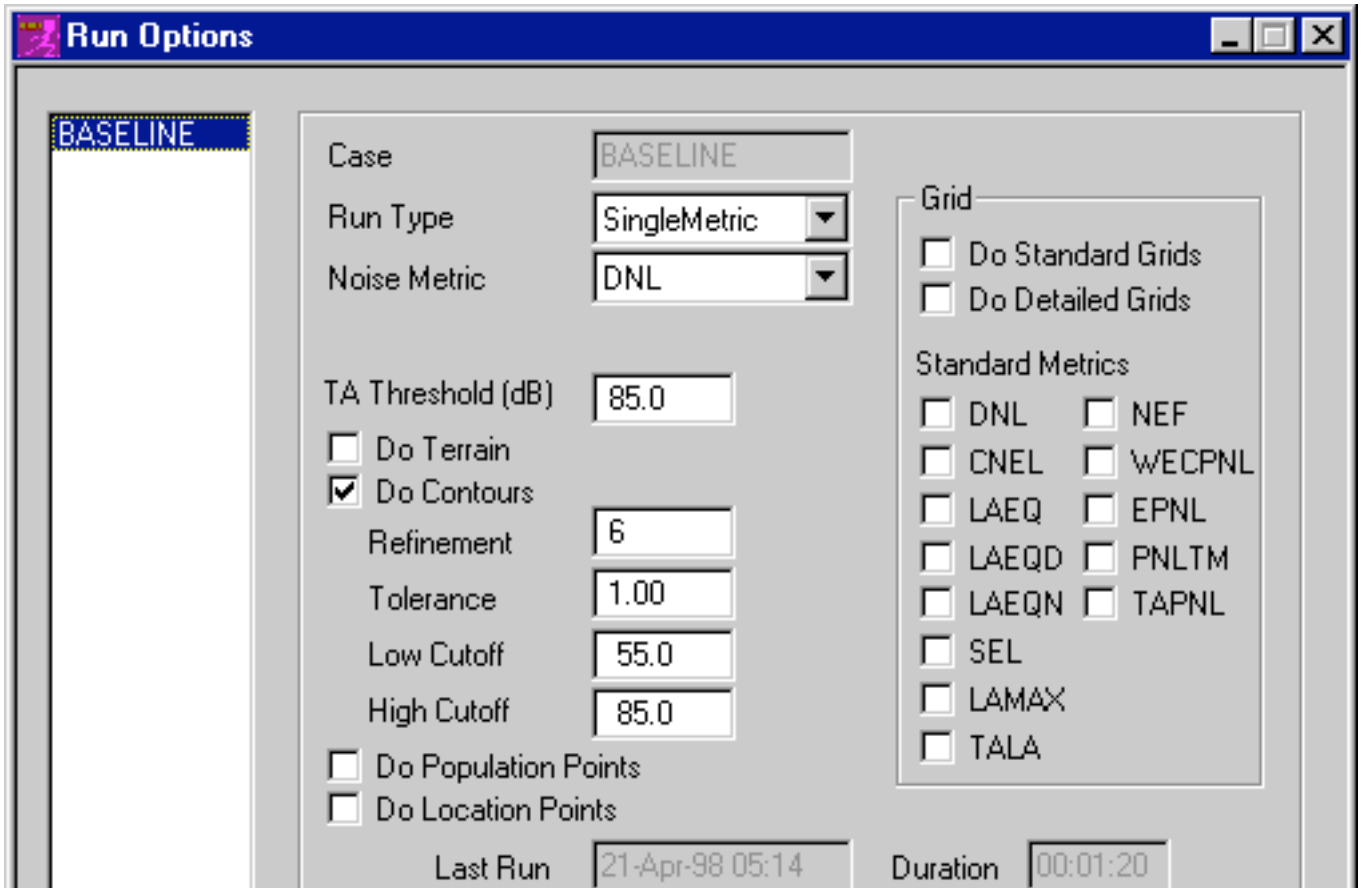
Grid Setup

Specifies the size and detail of the computational grid



Run Options

This screen lets you specify the output and metric used

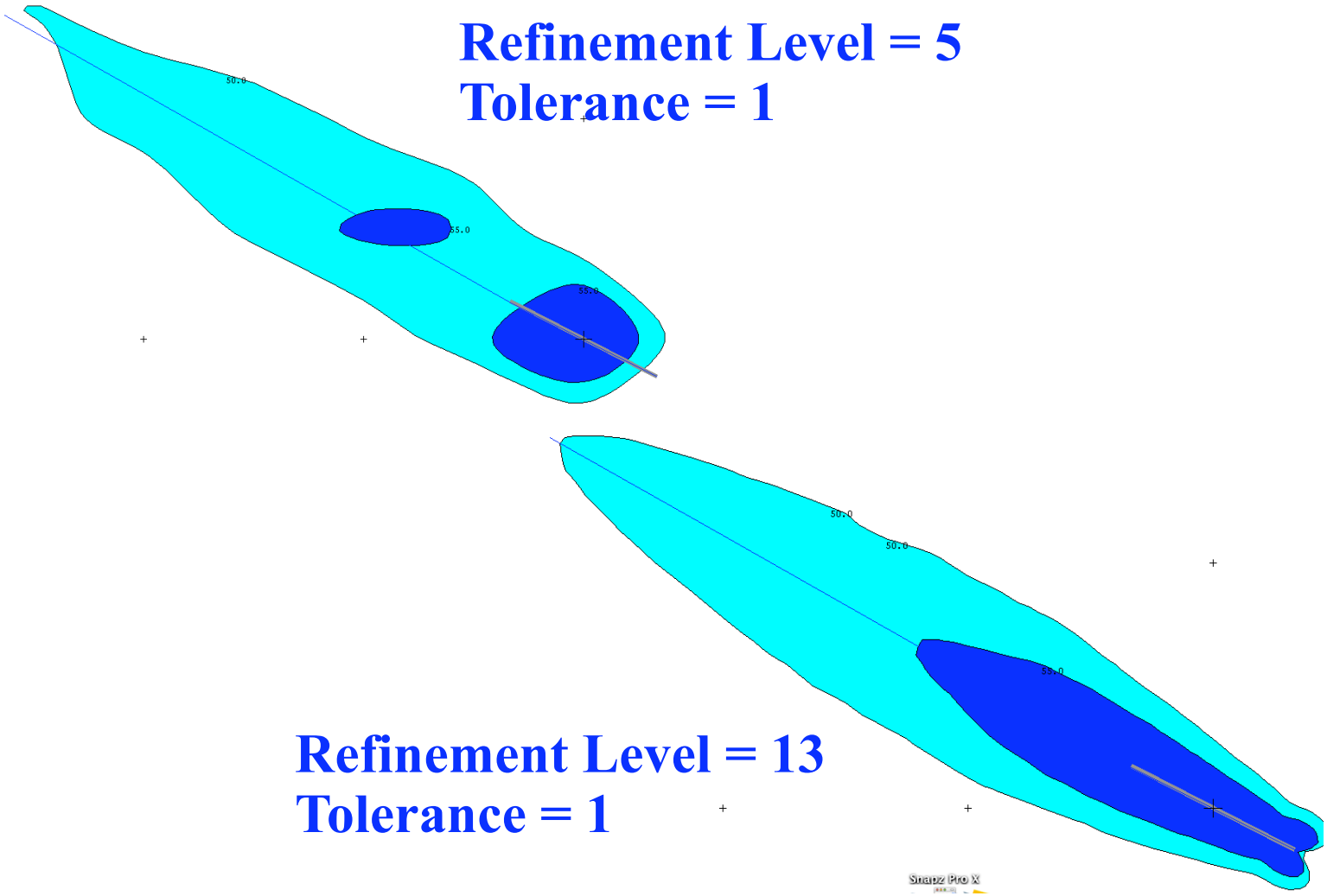


Run Options (cont.)

- The refinement level increases the number of interpolating points needed to calculate the contour lines. Use 10-13 refinement levels to achieve good results (e.g., well-defined contours). An example of two results using two refinement levels is shown in the next page.
- The tolerance also controls the interpolation algorithm to generate contours. Units are decibels. Smaller tolerance levels (say 0.5) produce better contours
- Terrain analysis if important if hilly or mountainous areas around the airport are expected to affect the size and shape of the noise contours.

Effect of Refinement Level in Noise Contours

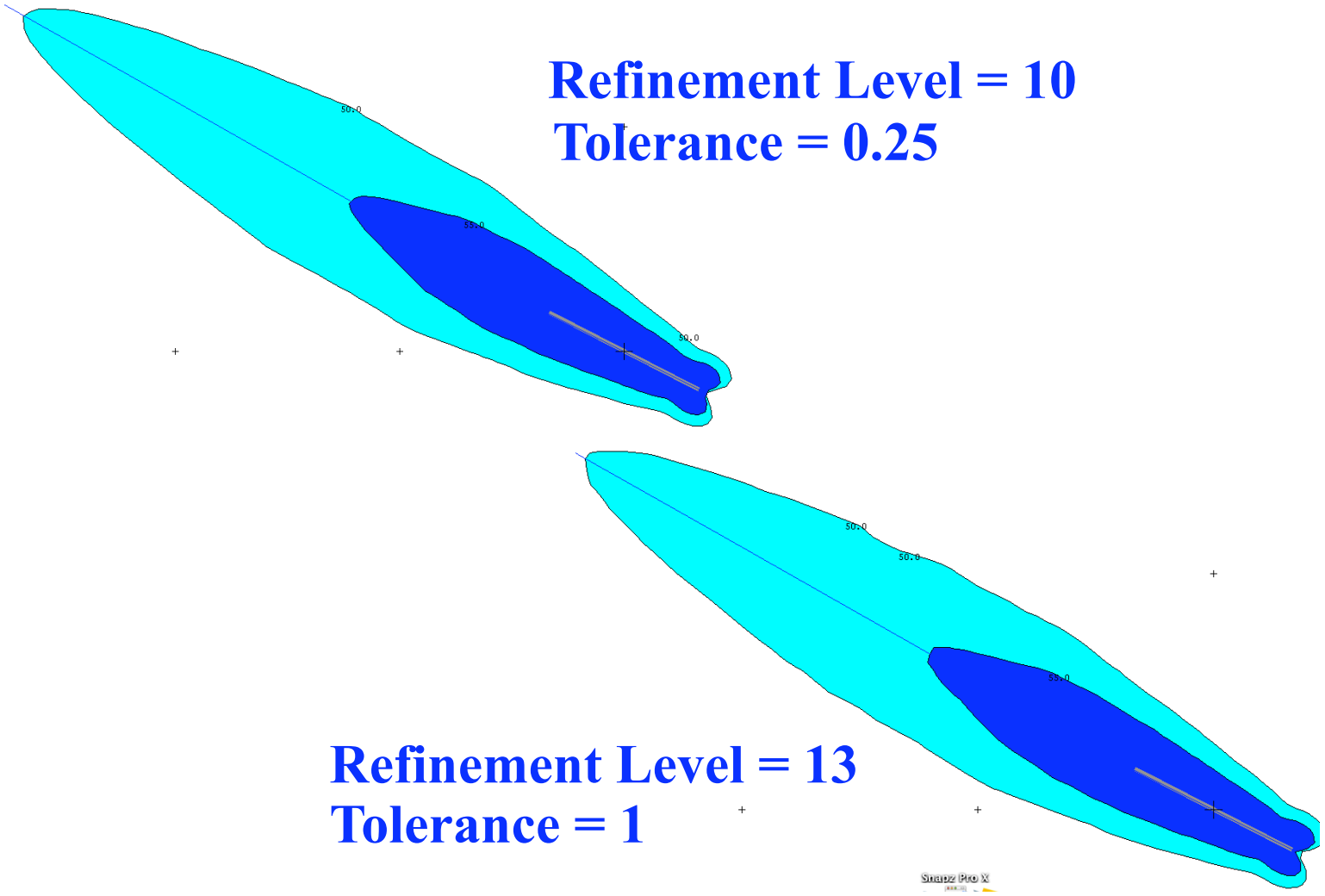
Refinement Level = 5
Tolerance = 1



Refinement Level = 13
Tolerance = 1

Effect of Tolerance Level in Contour Detail

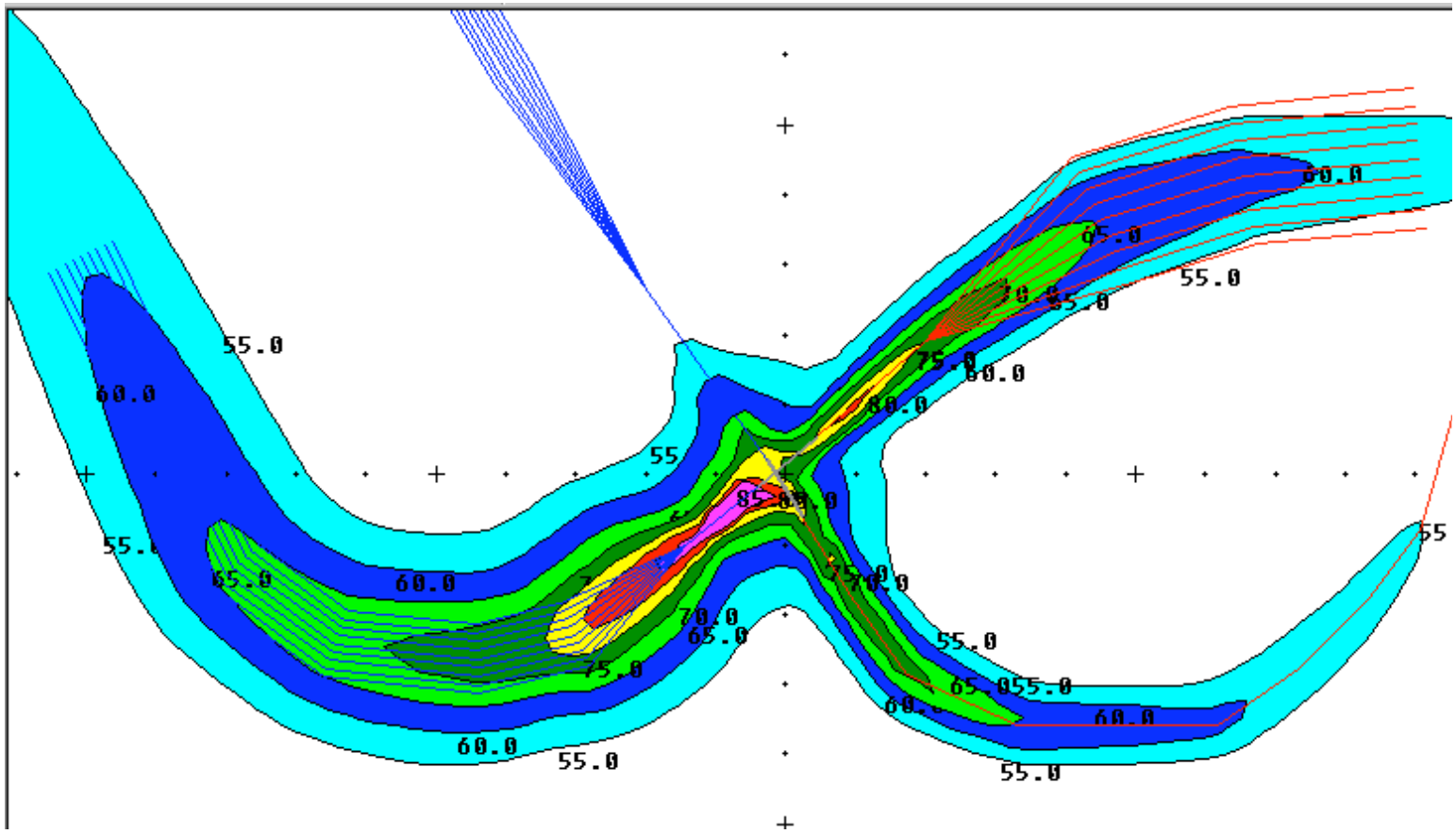
Refinement Level = 10
Tolerance = 0.25



Refinement Level = 13
Tolerance = 1

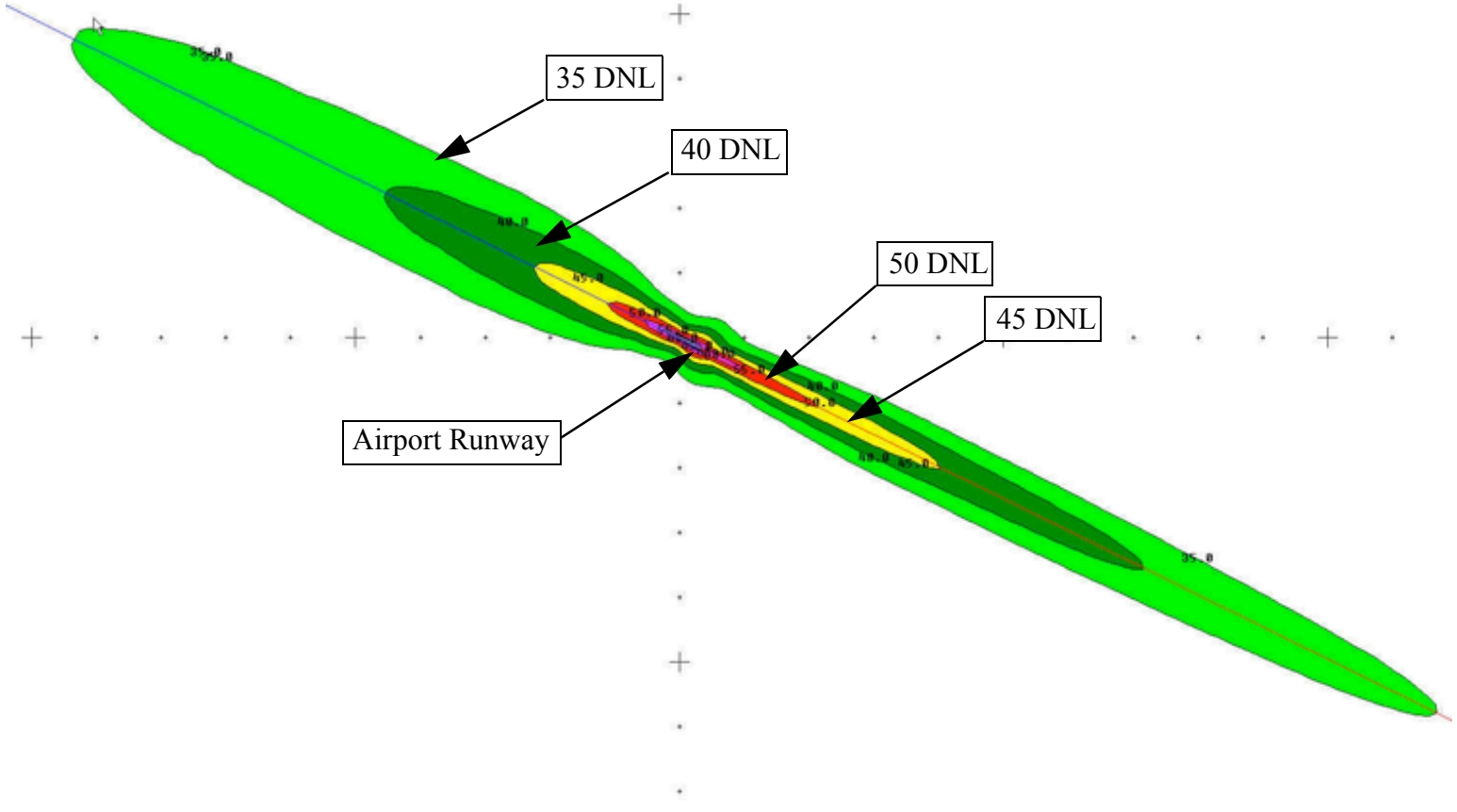
Output Graphics

Obtain output graphics creating an output scenario

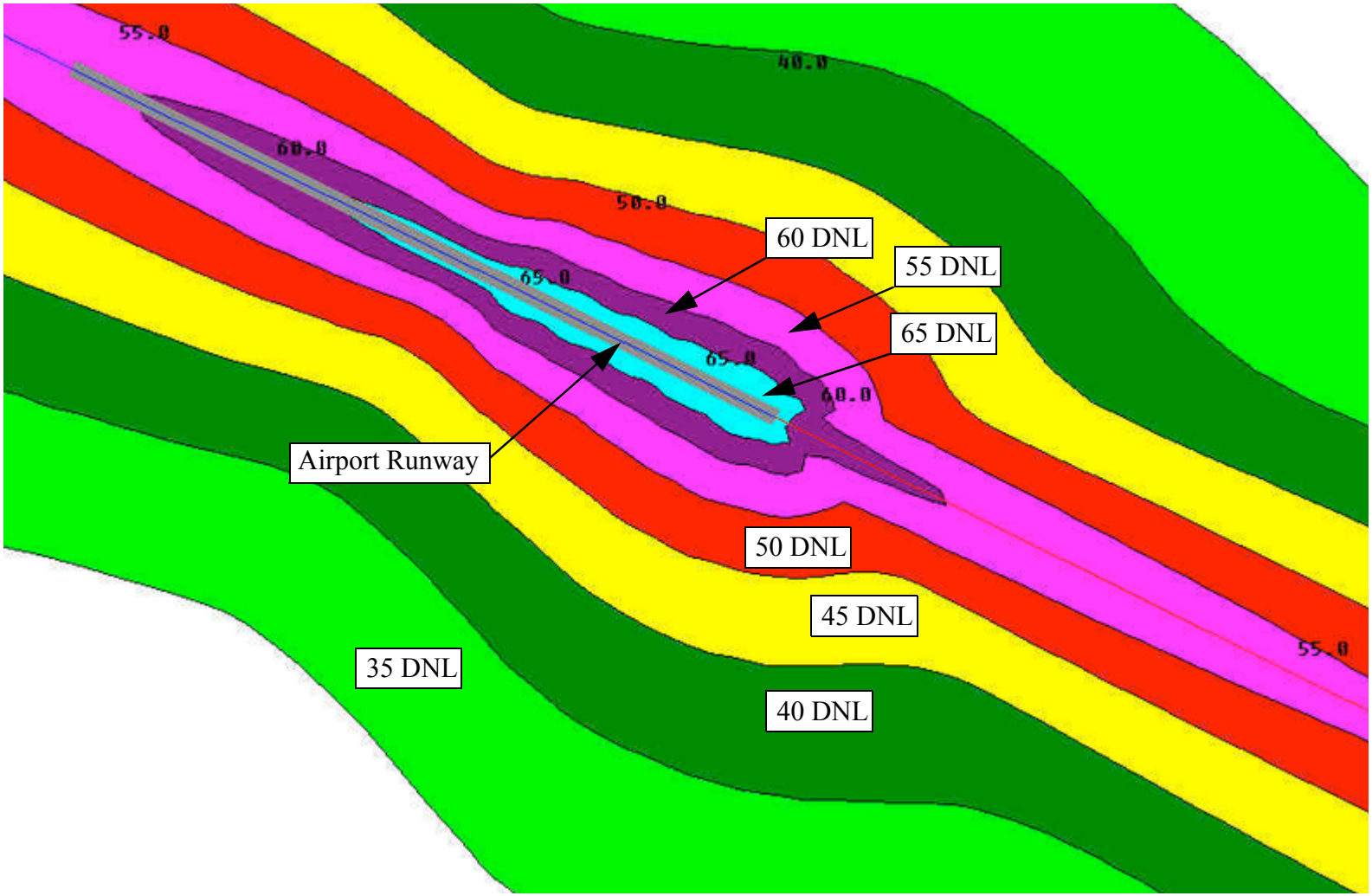


Noise Contours with Terrain Off

Straight-in and out contours (terrain algorithm off)

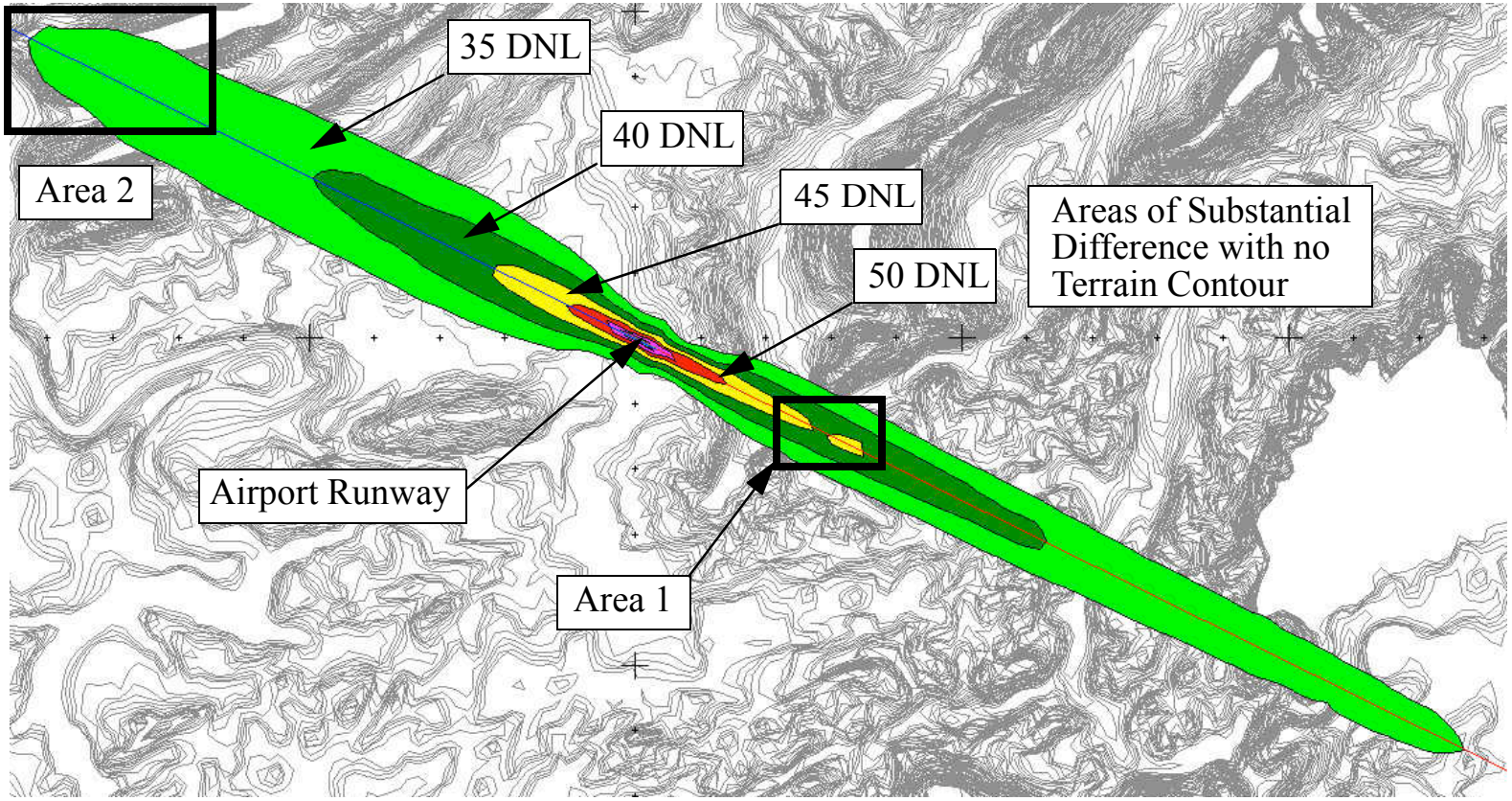


Close Up Contours (terrain algorithm off)



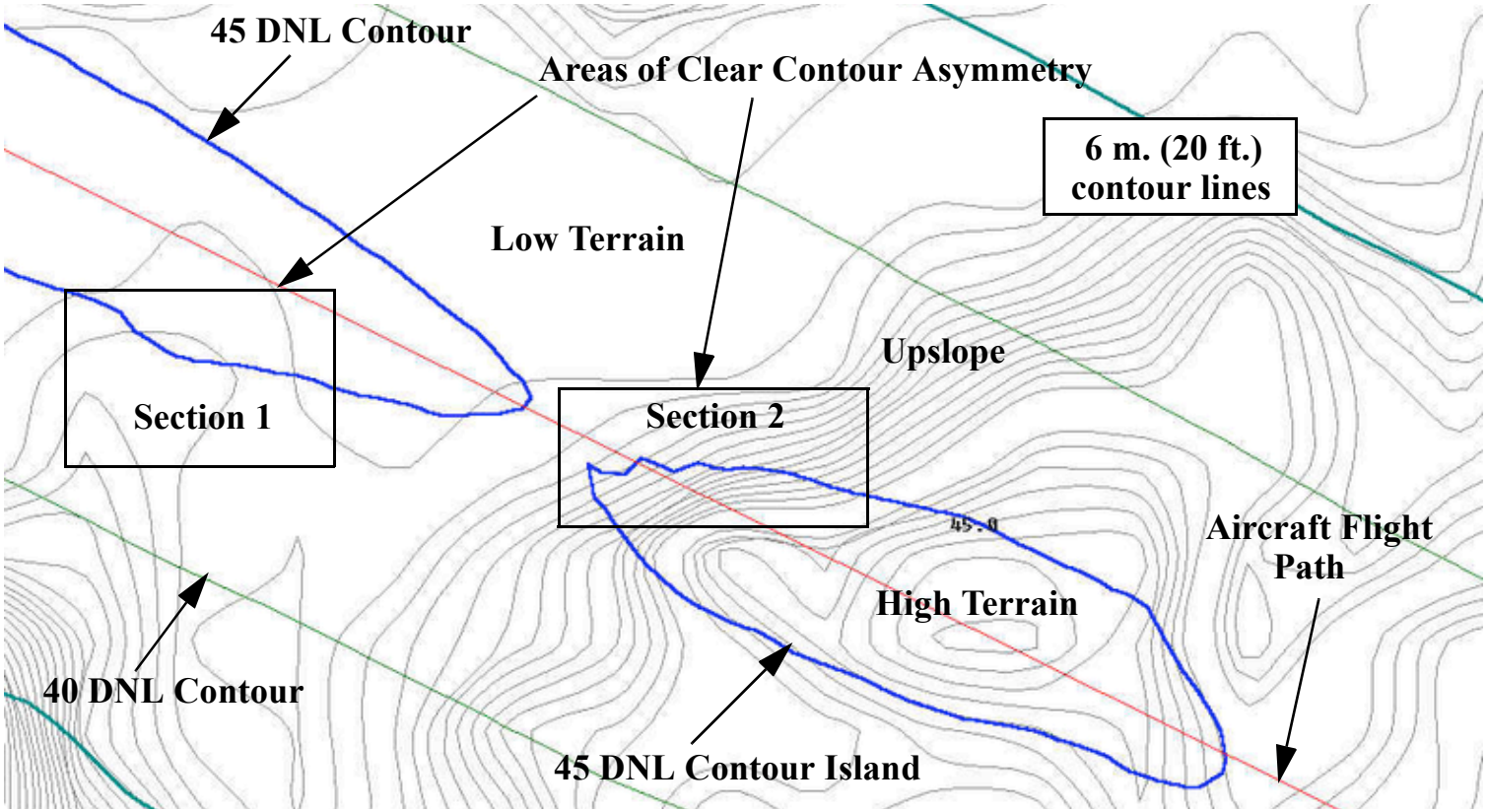
Contours with Terrain On

- Note the formation of island contours



Close Up Contours (terrain algorithm on)

- Note substantial changes in noise contours with the terrain algorithm turned on



Overflights and Touch and Go Operations

- INM can model overflights (flights whose destination or origin is not the airport in question)
- Touch and Go operations are typical of flight training
- INM can model touch and go operations
- Other special operations on the ground:
  - Run up operations - running an aviation engine on the ground to test the engine

Overflight Contours (Single-engine Aircraft)