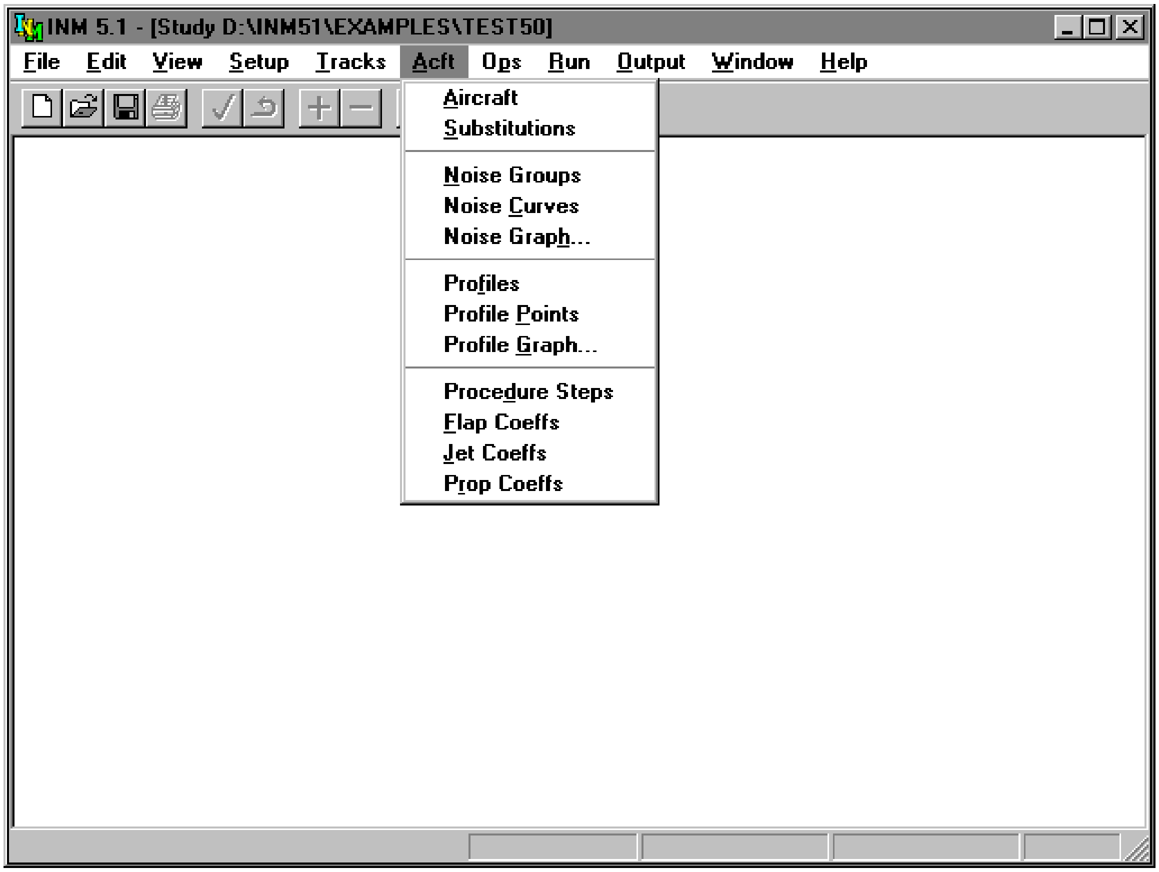
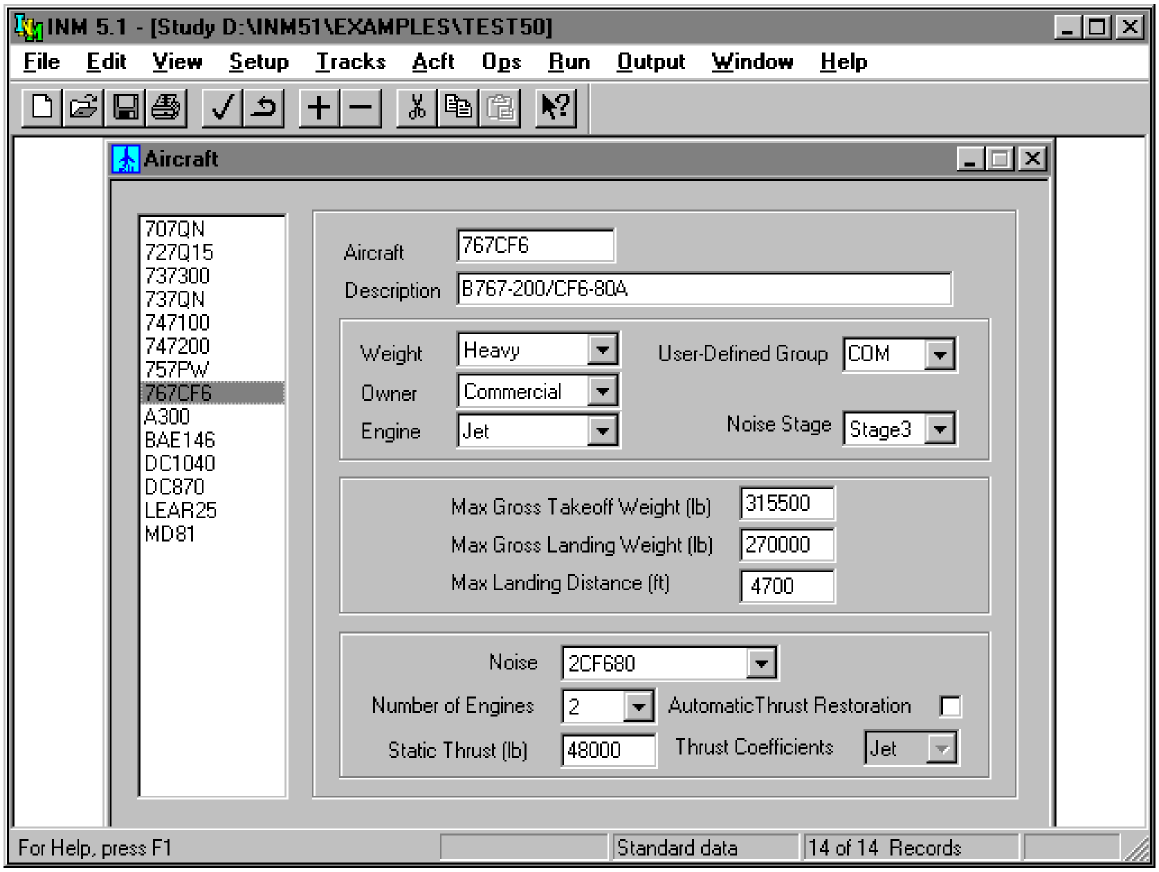


8. AIRCRAFT MENU

Use this menu to input data relating to Aircraft that are defined for your Study, including:

1) airplane attributes
2) aircraft substitutions
3) noise levels
4) profile points
5) profile procedures
6) performance coefficients.

Aircraft are defined at the Study level and are selectively used in Cases according to what you specify for flight operations (see Section 9).



8.1. Aircraft Data

Menu Item: Acft // Aircraft

Use this menu to view and add Aircraft records. The list on the left-hand side of the Aircraft window contains Aircraft that you declared for your Study.

You can include standard Aircraft not yet in your Study by using the Setup // Aircraft function.

You create new Aircraft records by using the Edit // Add Record function in this window. You can change an Aircraft record by making the modification in the edit controls on the right-hand side and committing the record with the Edit // Commit Record function.

Some Aircraft parameters are essential for computing noise contours, and others are not. In the list of 15 parameters below, the essential parameters are underlined.

1) The Aircraft identifier is used to associate an aircraft with its Profiles, Profile Points, Procedure Steps, and Coefficients. Also, the identifier is used by aircraft Substitutions and various kinds of flight operations.

2) A forty-character description of the Aircraft and its engines is used to provide additional information.

3) Weight class is "Small" (maximum gross takeoff weight is less than or equal to 12,500 pounds), "Large" (heavier than 12,500 but less than 300,000 pounds), and "Heavy" (300,000 pounds and heavier).

4) Owner category is "Commercial", "General Aviation", or "Military".

5) Engine type is "Jet" for turbojets, "Turboprop" for turbojet propeller-driven aircraft, and "Piston" for piston-engine propeller-driven aircraft.

6) The user-defined group identifier is the name of a set of Aircraft. You use the group identifier when creating flight operations by using the "operations-by-percent" function (see Sections 9.2 and 9.3).

   INM standard groups are COM (commercial), GA (general aviation), and MIL (military). You can add to these or change them. There is no limit to the number of aircraft groups. However, a given Aircraft can belong to only one group.

   When you assign an Aircraft to a group, make sure that all Aircraft in the group have similar Profiles. For example, if aircraft group G1 contains an Aircraft with C-Profiles ("C" for "close-in" Noise Abatement Departure Profile), and you plan on using C-Profiles in a Group Percents record, then all members of the aircraft group must have C-Profiles (you can find out why in Section 9.3).

   The INM standard database contains only S-Profiles ("S" for standard), so this condition is automatically met for Studies based on standard data.

7) Noise stage is the FAR Part 36 noise classification number. Since some INM standard Aircraft types are composed of several real aircraft types, noise stage is only representative of type and is presented here as a point of reference. This parameter is not used by INM.

8) Maximum gross takeoff weight is used to check for errors in Profile weight when calculating profiles using Procedure Steps. If you need to choose a nominal departure Profile weight, make it 85% of the maximum gross takeoff weight (recommended by SAE-AIR-1845). Profile weight must be less than maximum gross takeoff weight.

9) Maximum gross landing weight is used to check for errors in Profile weight when calculating profiles using Procedure Steps. If you need to choose a nominal approach Profile weight, make it 90% of the maximum gross landing weight (recommended by SAE-AIR-1845). Profile weight must be greater than 75% of maximum gross landing weight.

10) Maximum landing distance is the FAR Part 25 field length required for maximum gross landing weight. The distance is measured from the approach threshold (usually, the edge of the runway) and includes the in-air portion of the flight path before touchdown.

    The in-air portion is nominally 954 feet for a 3-degree approach, and it is 572 feet for a 5-degree approach for a threshold crossing height of 50 feet. The distance parameters needed in the Procedure Steps window for the Deceleration step can be computed by using this maximum landing distance (see Section 8.9.12).

11) The Noise identifier associates an Aircraft with its noise data. Some standard Aircraft use the same standard noise data.

12) The number-of-engines parameter is used to calculate engine-out thrust values for certain kinds of Procedure Steps. This is the only use of the number-of-engines parameter.

    Noise levels associated with an Aircraft do not change if the number of engines parameter is changed, meaning that this parameter is not connected to the noise data. Noise data implicitly account for the number of engines.

13) The static-thrust parameter is used to compute thrust in Procedure Steps. Static thrust must be in pounds, even when working the in metric system. Static thrust is for sea-level standard-day conditions. Two uses are made of this parameter, depending on the Noise Group thrust-setting type (see Section 8.3.1):

    - For Aircraft that have thrust-setting in pounds, static thrust is used to compute reverse-thrust and taxi-thrust using percentage parameters on Procedure Step records. For example, standard jet Aircraft usually use 60% static thrust for reverse thrust and 10% for taxi thrust.

    - For Aircraft that have thrust-setting in percent, static thrust is used to convert the percentage value to pounds when calculating profiles. Reverse-thrust and taxi-thrust are not computed for these Aircraft. Instead, the percentage values on the Procedure Step records are directly used to access noise data.

If an Aircraft exclusively uses Profile Points (profiles are not calculated from Procedure Steps), then the static-thrust parameter is not used. However, it is still a good idea to put a realistic number in this field.

14) The Automated Thrust Restoration System (ATRS) parameter is used in calculating Procedure Steps. If the box has a check mark in it, it means that the Aircraft has ATRS. An ATRS Aircraft uses zero-gradient engine-out thrust on the thrust-cutback segment, whereas a non-ATRS Aircraft uses positive-gradient thrust, which depends on the number of engines. All standard Aircraft are set to non-ATRS.

15) The thrust-coefficients parameter can be set to "Jet" or "Prop". "Jet" means that Jet Thrust Coefficients (and the associated SAE-AIR-1845 jet-thrust equation) are used to calculate the "corrected net thrust per engine", which is the parameter used to access noise data. "Prop" means that the Prop Thrust Coefficients are used instead (see Sections 8.11 and 8.12).

    Many standard Aircraft do not have thrust coefficients (their profiles are not computed). They are set to "Jet" or "Prop", depending on their engine type, but the parameter is not used.

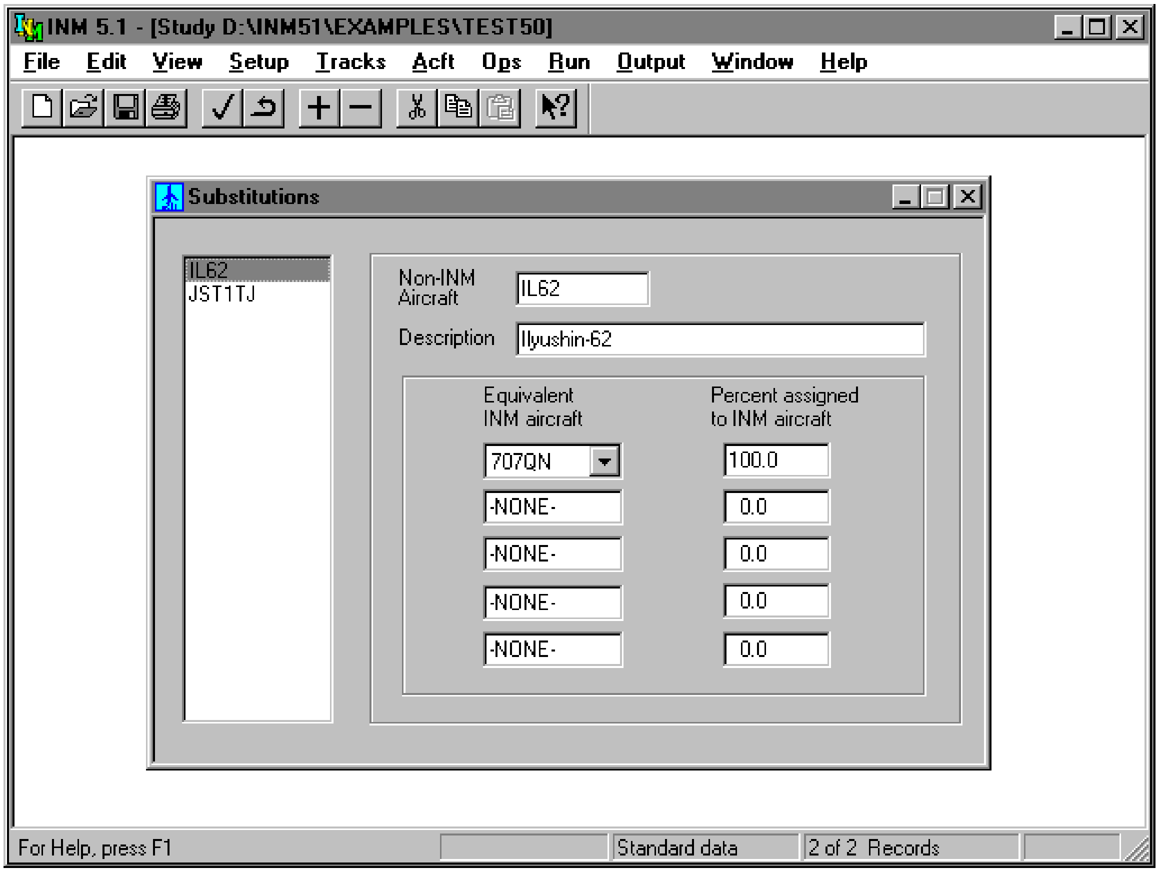
    Note that INM standard turboprop Aircraft are usually classified as "Prop", but there are two that are classified as "Jet" (DHC8 and DHC830). This means that turboprops can use either type of thrust equation.

Sometimes, you may want to make a copy of standard Aircraft data and then make changes. There is a special way to copy Aircraft data:

- Change the Aircraft identifier to something else, and commit the record. INM marks the changed Aircraft record as user-generated and displays "User data" on the status bar. INM also marks all the records belonging to the Aircraft as user-generated records (for example, all Flaps records).

- Use the Setup // Aircraft function to retrieve the original standard Aircraft and its associated records. You now have the standard Aircraft and a complete copy.

Please note that if you change an Aircraft identifier, all substitution and operation records that are associated with the Aircraft will be updated with the new identifier.



8.2. Aircraft Substitution Data

Menu Item: Acft // Substitutions

The Substitutions list on the left-hand side of the Substitutions window contains the aircraft Substitutions that you declared for your Study.

You can include more standard Substitutions by using the Setup // Substitutions function. You can create new Substitution records by using the Edit // Add Record function in this window.

Substitution identifiers are similar to Aircraft identifiers. In fact, these identifiers appear in Aircraft lists when you construct flight operations. They are indicated by "(s)" after their identifiers. You can use Substitutions as though they were declared Aircraft types.

INM standard Substitutions (the ones on the Setup // Substitutions list) are approved by the FAA for use in INM studies. If you are unable to find an aircraft in the substitution database, refer to the contact provided in Appendix A for INM aircraft substitutions.

A few substitutions in the FAA substitution list are not included in the INM database. These substitutions require changes in noise levels, usually because the substitution aircraft has a different number of engines than the standard aircraft. Additional FAA approved substitutions are:

```
Falcon 50                                        LEAR35 + 1.8 dB
Falcon 900                                       LEAR35 + 1.8 dB
Yakovlev Yak-40                                  LEAR35 + 1.8 dB
Antonov AN-225                                   74720B + 1.8 dB
DC9-30 JT8D-9A or JT8D-7B with hushkit           727EM2 - 1.8 dB
DC9-31 JT8D-9A or JT8D-7B with hushkit           727EM2 - 1.8 dB
737 with Nordham retrofit or hushkit             727EM2 - 1.8 dB
```

You need to create new Aircraft and Noise data for the above substitutions. All points on the SEL and EPNL noise curves should be adjusted by the indicated amount.

To create an aircraft Substitution:

1) Input a six-character identifier and a forty-character description. The Substitution identifier <u>must be different</u> from any Aircraft or other Substitution in your study.

2) Select from one to five study Aircraft that will be used in place of your aircraft. If an Aircraft you need is not on the list, you can bring it into the Study from the INM system, or you can create it.

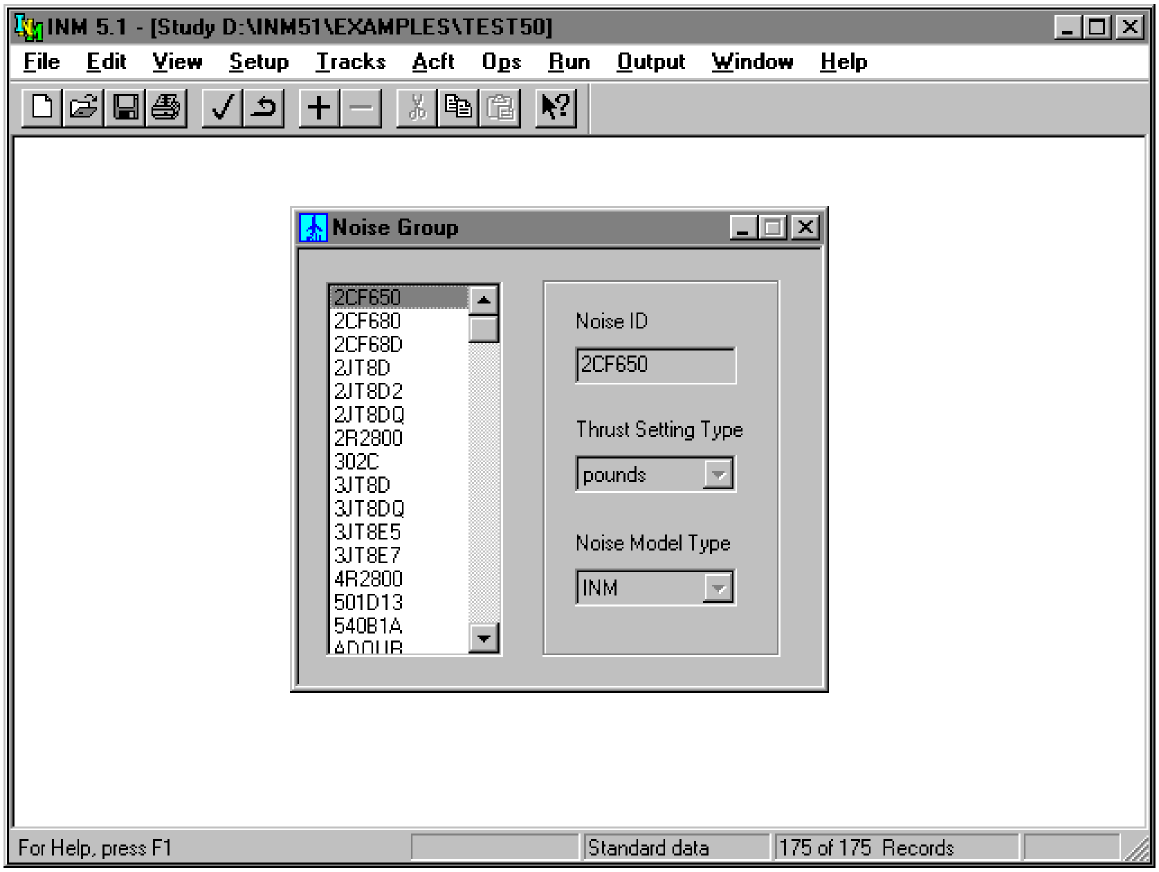
3) If just one Aircraft represents your aircraft, put it in the top box, enter 100 in the percent box, and leave the other boxes with "-NONE-" and "0" in them. If you want your aircraft to be split into two or more (up to five) Aircraft, fill out the boxes accordingly and in order. Please make sure that the percentages add up to 100 percent.

INM uses the specified Aircraft in place of your Substitution aircraft when calculating numbers of operations. The numbers of operations are spilt according to the percentage values.

- For example, if you create a Substitution aircraft 737X and make it equal to 20% of 737300 and 80% of 737400, then 100 737X operations are expanded to 20 737300 operations and 80 737400 operations.

All Aircraft on a Substitution record must have the same profile group identifier, or else INM cannot correctly expand the substitution.

For example, if you specify a DEP-C2 Profile for a substitution Flight Operation, all of the Aircraft on the Substitution record must have a DEP-C2 Profile. You can check the FLIGHT.ERR file in the Case subdirectory for this kind of problem.



8.3. Noise Groups

Menu Item: Acft // Noise Groups

A Noise Group record identifies a set of Noise Curve records (see Section 8.4, below). Three input parameters are needed to define a Noise Group:

1) six-character noise identifier
2) type of thrust setting used to identify the noise curves
3) type of lateral attenuation model and max-level model to apply.

8.3.1. Thrust Setting Type

The types of thrust-setting are:

- pounds
- percent
- epr (engine pressure ratio)
- other.

Only those Aircraft associated with pounds or percent thrust-setting types can have profiles that are computed from Procedure Steps. This is because the equations for corrected net thrust per engine use coefficients related to pounds (or equivalently, static thrust in pounds multiplied by percent divided by 100).

Aircraft associated with epr or other do not show in the aircraft display list for Procedure Steps. These Aircraft must use profiles constructed from Profile Points.

At this time, "epr" and "other" are essentially the same, except that "epr" is numerically limited to realistic values, whereas "other" can have any value. Later versions of INM may include thrust equations for "epr" type noise parameters.

8.3.2. Lateral Attenuation Model

Your choice for the type of lateral attenuation model is INM or NoiseMap.

The INM lateral attenuation model is in SAE-AIR-1751 and repeated in SAE-AIR-1845:

When the airplane is on the ground:

$$G = 15.09 \; (1 - \exp(-0.00274 \; D)) \quad \text{for } 0 <= D <= 914 \text{ m}$$
$$G = 13.86 \quad \text{for } D > 914 \text{ m}$$

Where G is ground-to-ground attenuation (dB), and D is the horizontal lateral distance to the airplane (meters).

When the airplane is airborne:

$$A = (G / 13.86) \; (3.96 - 0.066 \; \beta + 9.9 \exp(-0.13 \; \beta)) \quad \text{for } 0 <= \beta <= 60$$
$$A = 0.0 \quad \text{for } 60 < \beta <= 90$$

Where A is air-to-ground attenuation (dB), and β is the elevation angle to the airplane (degrees).

The NoiseMap lateral attenuation model is given by:

When the airplane is on the ground:

$$G = 15.09 \; (1 - \exp(-0.00274 \; D)) \quad \text{for } 0 <= D <= 401 \text{ m}$$
$$G = 10.06 \quad \text{for } D > 401 \text{ m}$$

Where G is ground-to-ground attenuation (dB), and D is the horizontal lateral distance to the airplane (meters).

When the airplane is airborne:

```
A = G                                                for 0 <= β <= 2
A = ( G / 10.06 ) ( (21.056 / β) - 0.468 )           for 2 < β <= 45
A = 0.0                                              for 45 < β <= 90
```

Where A is air-to-ground attenuation (dB), and β is the elevation angle to the airplane (degrees).

8.3.3. Max-Level Model

Your choice for the type of max-level model is also INM or NoiseMap. The max-level model is also known as a "effective time-duration correction" for aircraft flying at 160 knots reference speed.

Maximum noise levels are used in calculating time-above metrics and maximum-level noise metrics. INM uses standard and/or user-defined input values for LAMAX and PNLTM when they are available. When LAMAX and/or PNLTM data do not exist, INM uses equations that are derived via linear regression analyses using INM standard data.

The <u>INM max-level model</u> is given by:

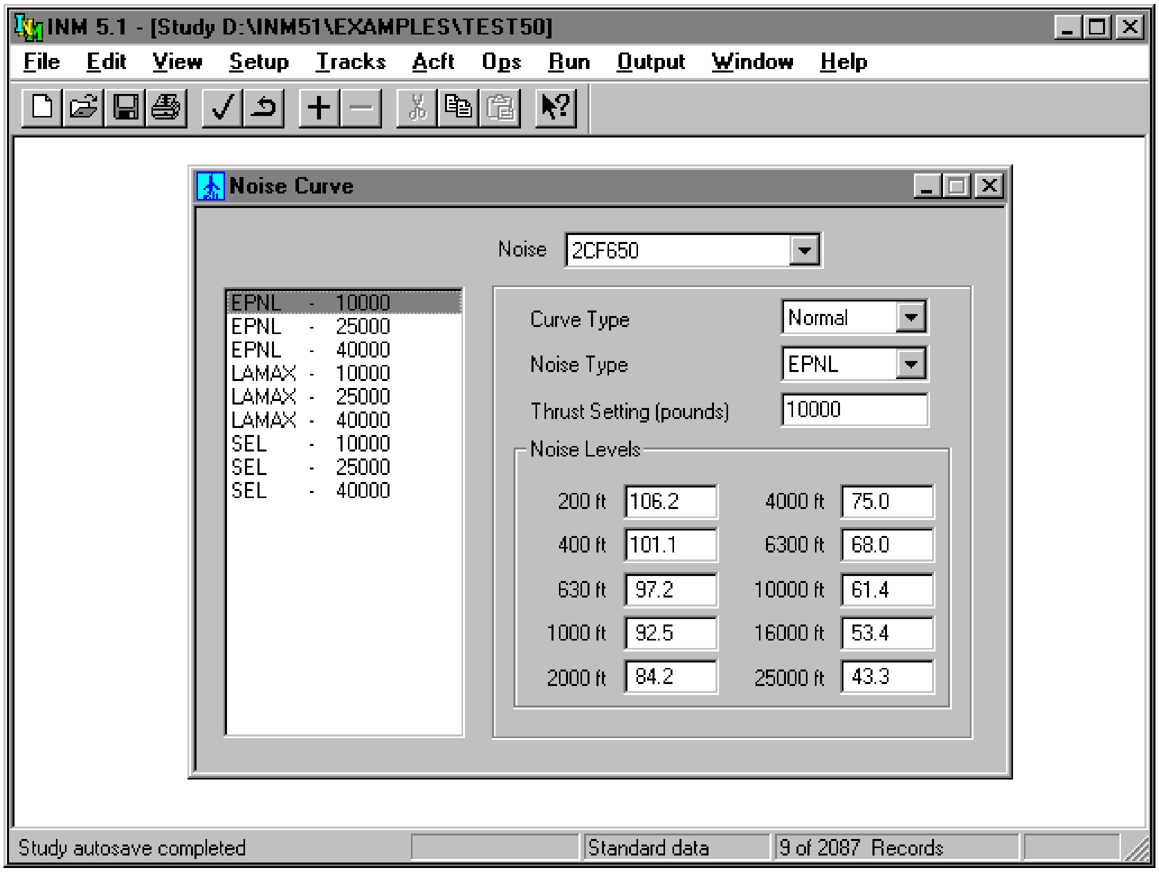
```
LAMAX  =  SEL  - 7.19 - 7.73 log( D / 1000 )
PNLTM  =  EPNL + 1.12 - 9.34 log( D / 1000 )
```

The <u>NoiseMap max-level model</u> is given by:

```
LAMAX  =  SEL  - 7.48 - 6.06 log( D / 1000 )
PNLTM  =  EPNL + 2.51 - 5.84 log( D / 1000 )
```

Where log is the base-10 logarithm function, and D is slant distance to the airplane (feet).

Because of the derived relationship between maximum level and exposure level, you do not have to create both LAMAX and SEL curves (or PNLTM and EPNL curves). You can create one set of curves and INM will compute the other. For example, you can input PNLTM values and INM will compute the EPNL values. Obviously, you have more control by creating both sets of curves.



8.4. Noise Curves

Menu Item: Acft // Noise Curves

Use this function to view and create noise-power-distance (NPD) curves. The members of a set of NPD curves have the same Noise identifier and the same "noise type". For example, the CF66D SEL set of curves consists of six records with thrust ranging from 8000 to 36000 pounds per engine.

You can add a NPD curve with the Edit // Add Record function. Be sure to create at least two records for each NPD set.

You need to fill out the following data items to define a NPD curve:

- type of curve
- type of noise
- thrust setting value
- noise levels at ten distances.

8.4.1. Curve Type

Your choices for type of curve are Normal and Afterburner.

- INM interpolates a "normal" set of curves when calculating a noise level that is between two NPD curves. For example, the noise level for 8550 pounds is calculated by linear interpolation using two given NPD curves at 8000 and 12000 pounds.

- INM does not interpolate "afterburner" curves. Instead, thrust values along an afterburner flight segment are read directly off the NPD curve. Afterburner curves do not form sets.

Always use Normal type curves, unless you are trying to model afterburner noise for a military aircraft.

Only the Normal type NPD curves can used in Procedure Steps. This is not too restrictive because NOISEMAP Aircraft (for which there are afterburner curves) do not have performance coefficients, and therefore they cannot have Procedure Steps anyway.

8.4.2. Noise Type

Your choices for type of noise are:

- SEL — single-event Sound Exposure Level at a reference speed of 160 knots. It belongs to the A-weighted noise family. It is measured in decibels relative to $(20\ \mu Pa)^2(1\ s)$.

- LAMAX — maximum sound level. It belongs to the A-weighted noise family. It is measured in decibels relative to $(20\ \mu Pa)^2$.

- EPNL — single-event Effective Perceived Noise Level at a reference speed of 160 knots. It belongs to the perceived, tone-corrected noise family. It is measured in decibels relative to $(20\mu Pa)^2(10\ s)$.

- PNTLM — maximum perceived noise level. It belongs to the perceived, tone-corrected noise family. It is measured in decibels relative to $(20\mu Pa)^2$.

"A-weighting" and "perceived, tone-corrected weighting" are two common methods of adjusting (weighting) a measured noise spectrum so that it better represents human perceived noise.

SEL and EPNL exposure levels are for aircraft flying at a reference speed of 160 knots, at a fixed thrust setting, along a straight and level overhead flight path. INM adjusts the exposure levels for the actual speed flown.

You do not have to create both SEL and EPNL sets. For example, if all you are interested in is SEL and related A-weighted noise metrics, you can just create the SEL set of NPD curves.

However, if you do this, only A-weighted noise metrics are valid, even though perceived-noise metrics may be computed. The reason is that the aircraft that are associated with your SEL-only noise identifier are missing EPNL-related data. Therefore, the perceived-noise metrics will not have noise contributions from those aircraft.

8.4.3. Thrust Setting

The thrust-setting parameter is corrected net thrust per engine, whether it is in pounds, percent of static thrust, or other units. “Corrected" means that the actual thrust setting at the aircraft altitude and ambient temperature is divided by the ratio of the ambient atmospheric pressure over the sea-level standard pressure. Thus, the thrust setting is "corrected" back to sea-level standard day.

Even though the NPD curves are identified by “thrust per engine”, the noise levels include the contribution from all the engines.

Profile Points thrust settings must be in the same units (must be commensurate with) the thrust-setting identifiers on the NPD curves.

You can create a “normal” thrust setting and an “afterburner” thrust setting using the same numerical value.

Appendix J cross references Noise identifiers to the Aircraft that use them. Note that more than one Aircraft can use a given set of NPD curves.

8.4.4. Noise Levels

The NPD curves are defined by 10 noise levels at 10 fixed distances. For exposure levels, "distance" is the distance from an observer to the closest point of approach along a straight flight path. For maximum levels, "distance" is the distance at which the maximum level is generated.

The 10 fixed distances are chosen so that they are approximately evenly spaced on a logarithmic scale:

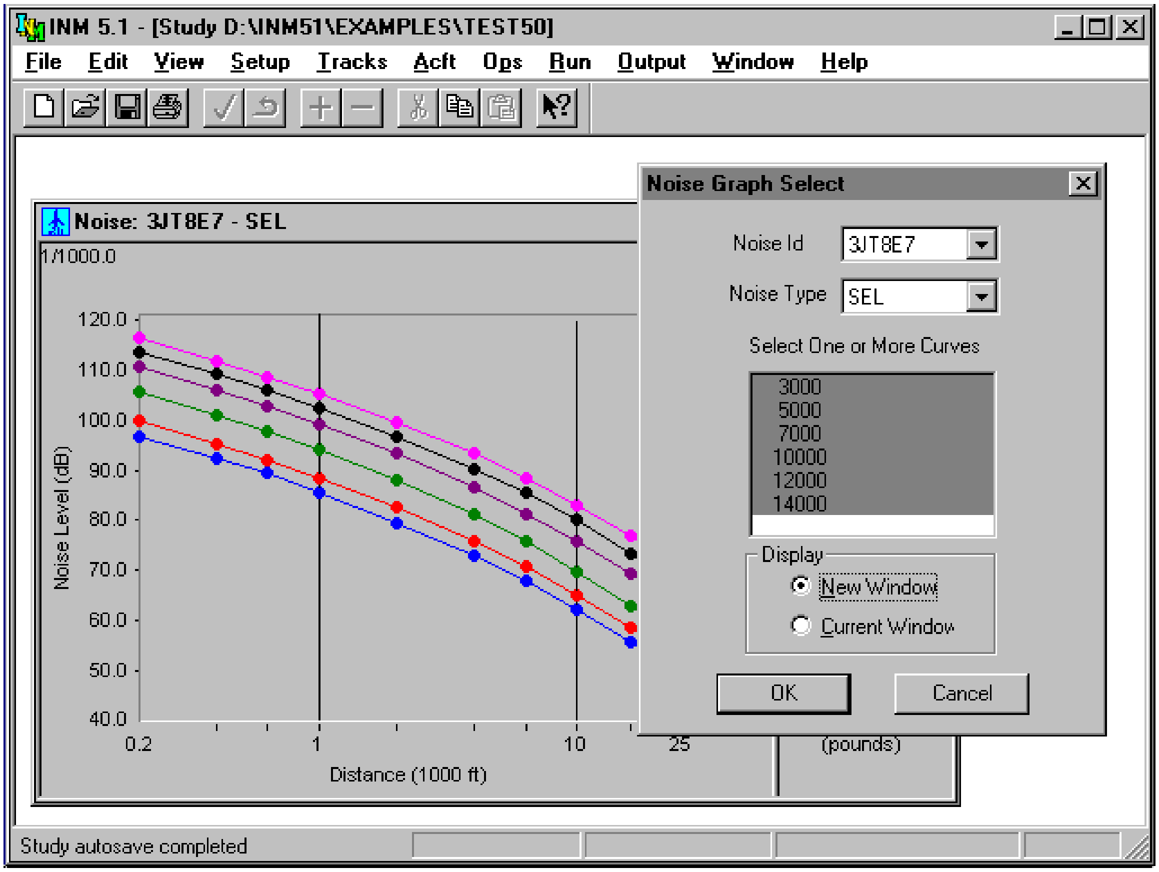
```
  200 ft      =    61.0 m
  400 ft      =   121.9 m
  630 ft      =   192.0 m
 1000 ft      =   304.8 m
 2000 ft      =   609.6 m
 4000 ft      =  1219.2 m
 6300 ft      =  1920.2 m
10000 ft      =  3048.0 m
16000 ft      =  4876.8 m
25000 ft      =  7620.0 m
```

Noise levels must get smaller as distance increases. If not, you will see a message about "monotonic decreasing" levels when you try to commit the record.

INM uses straight-line interpolation between points to calculate noise level at a given distance and for a given thrust value. Noise level and thrust setting are on linear scales, and distance is on a logarithmic scale. There must be at least two records (curves) per "normal" set so that thrust setting values can be interpolated or extrapolated.

For distance less than 200 feet, INM uses –10 dB/decade for extrapolating exposure levels (for example, SEL decreases 10 dB when going from 20 feet to 200 feet). INM uses –20 dB/decade for extrapolating maximum levels. For distances beyond 25,000 feet, INM uses the last two points (at 16,000 and 25,000 feet) for straight-line extrapolation on a logarithmic scale.

A few standard NPD sets look odd because curves cross over other curves (for example, PW120). This is caused by mixing data obtained from low-thrust approach measurements with data obtained from higher-thrust departure measurements. Aircraft are configured differently for approach than for departure (gear, flaps, attitude, etc.) and the shape of the two frequency spectra can be different, thus causing an occasional cross-over.



8.5. Noise Graph

Menu Item: <u>Acft // Noise Graph</u>

You can view a graph of noise level versus distance by first selecting a Noise identifier and then its noise type (SEL, LAMAX, EPNL, PNLTM).

INM pre-selects all the curves — all you have to do is press "OK" to see the graph. If you want to limit the number of curves on the graph, you can de-select some of the records before pressing OK.

Select "New Window" if you want INM to create another Noise Graph. Select "Current Window" to overwrite data in the current Noise Graph.

You can watch your noise levels being plotted as you commit each new NPD curve record. To do this, setup two windows side by side; one is the Noise Curve window and the other is the Noise Graph window. Get the new NPD set of curves started first (see Section 8.4) and then run Noise Graph. Each time you commit a new record, a curve is plotted on the graph as you watch.

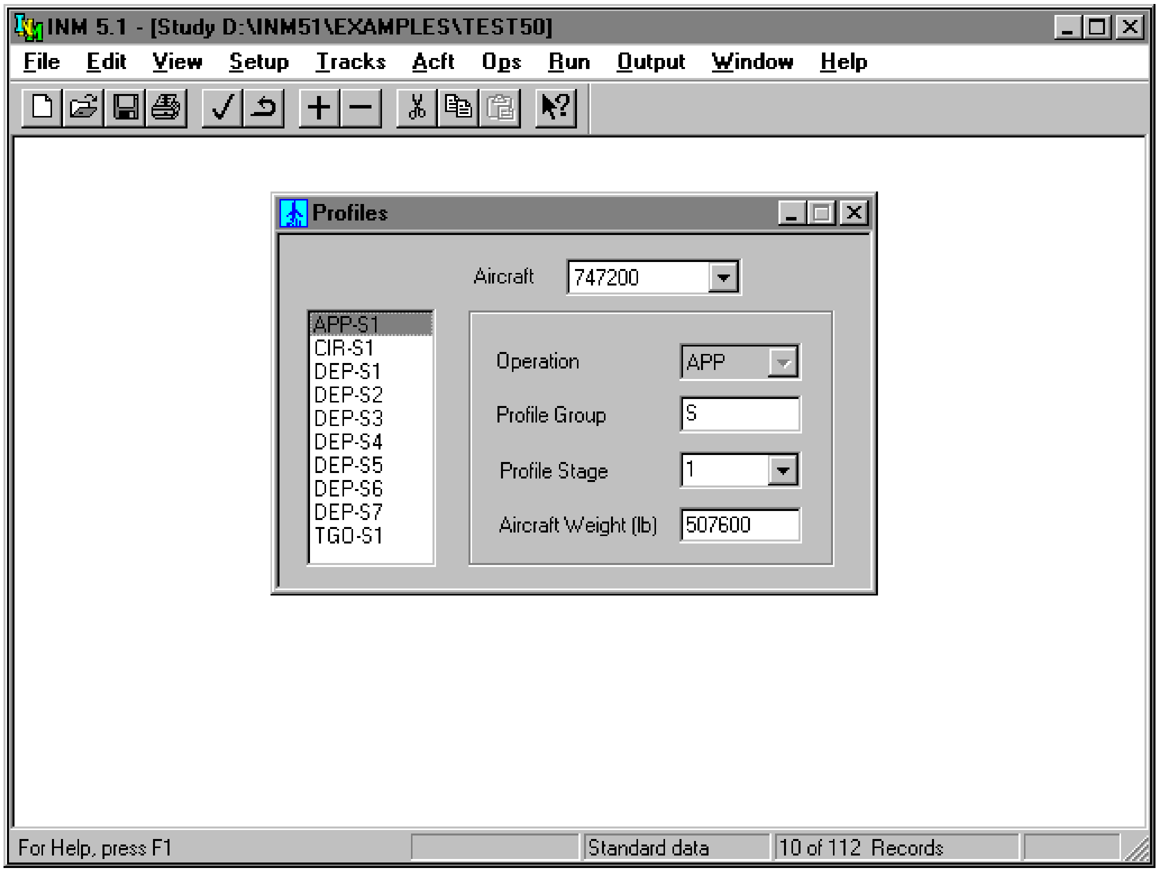
You can view the distance (X value) and the noise level (Y value) by double-clicking on a dot on the graph. A pop-up message bubble displays the X,Y values. You can remove the pop-up by clicking once anywhere.

There are three ways to get NPD hardcopy:

- While the Noise Curve window is active, use the File // Export As function to print a text file or DBF file of NPD data points.

- While the Noise Graph window is active, use the File // Print function to print the NPD graph to a printer or to a file.

- While the Noise Graph window is active, use the Edit // Copy function to copy the graphic to Windows Clipboard as a metafile (WMF format). The resulting data can be saved to disk, or directly pasted into a graphics program for manipulation and printing.



8.6. Profile Data

Menu Item: Acft // Profiles

Use this function to create a Profile object before creating related Profile Points or Procedure Steps. Profile data include:

1) type of operation
2) one-character profile group identifier
3) single-digit profile stage number
4) aircraft weight during the operation.

8.6.1. Operation Type

INM 5.1 supports five types of flight profile operations:

A	APP	Approach
D	DEP	Departure
T	TGO	Touch-and-Go
F	CIR	Circuit Flight
V	OVF	Overflight.

Notice that there is a CIR profile but no corresponding CIR track (Section 7.4). This is because a CIR profile is matched to TGO track. You create a complete touch-and-go operation by defining a TGO track, a TGO profile, a CIR profile, and two Flight Operations: one using the TGO track and TGO profile, and the other using the TGO track and the CIR profile.

8.6.2. Profile Group

Profile group is a one-character identifier. It is called "group" because it identifies Profiles that belong to the same group (for example, "C" is a close-in departure group).

All standard Profiles use the letter "S" for their group identifier. To reduce confusion about what is standard and what is not, you should not use "S" when creating Profiles.

8.6.3. Profile Stage

Profile stage is a one-digit number. It is called "stage" because it is used to identify stage lengths for departure Profiles. Stage length is a range of trip distances. INM stage lengths are defined as follows:

```
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            over   4500  nmi
```

There is only one standard approach Profile for most standard Aircraft, and its stage number is set to "1". Some small standard GA aircraft have both "1" and "2", representing 3-degree and 5-degree approaches.

Approach stage numbers have nothing to do with stage lengths. They are just a way of distinguishing members in a group. For example, you could use approach stages to mean different descent angles.

You can use the stage numbers that are already defined by selecting them from the drop-down list, or you can create your own by typing a single digit (0 to 9) in the box.

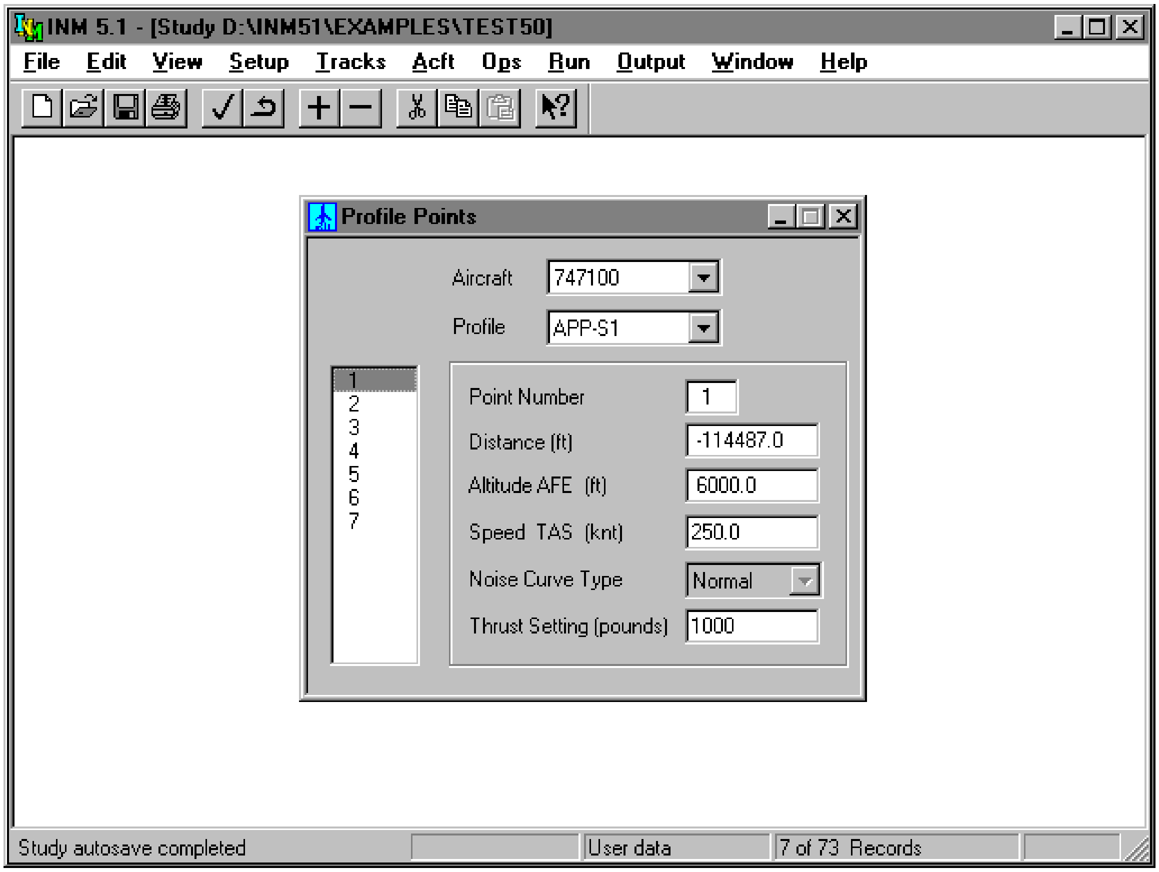
8.6.4. Profile Weight

Profile weight is the weight of the aircraft during the operation. If Profile Points are used to specify the profile (see Section 8.7), the weight parameter has no effect — INM does not use it.

However, if Procedure Steps are used to specify the profile (see Section 8.9), profile weight influences the amount of thrust required along the flight path and the altitude that can be attained in a given amount of ground distance, thus affecting the noise produced by the airplane.

You should make sure that the Profile weight:

- Is greater than 75% of the maximum gross landing weight.
- Is less than the maximum gross takeoff weight.
- Is less than maximum gross landing weight for approach and touch-and-go operations.
- Is the same for TGO and CIR profiles that are to be used together in a touch-and-go operation.



8.7. Profile Points Data

Menu Item: Acft // Profile Points

Use this function to specify a profile in terms of distance, altitude, speed, and thrust-setting values at various points along a flight path.

The advantage of using Profile Points (instead of Procedure Steps) is that you have complete control over the details of a profile. The disadvantage is that the profile is fixed, and INM cannot change it in response to different airport temperature or wind conditions.

To create a set of Profile Points, you first select an Aircraft and a Profile. Then, use the Edit // Add Record function (or Add button) and tab through the fields, entering data as you go.

The point numbers keep the records in order. The point number should start with 1 and be incremented by 1 for each new record. A given Profile can have as many as 999 Profile-Point records. After a record is completed, use the Edit //

Commit Record function (or Check button). You can also commit a record by adding another new one.
Fifteen standard Aircraft use Profile Points for some or all of their profiles:

```
707        727EM2     F16PW0
707120     747100     F15PW9
720        DC820      MD11GE (approach only)
727200     F16A       MD11PW (approach only)
727EM1     F16GE      SABR80
```

You can use these profiles as examples for how to build approach and departure profiles using Profile Points.

Always check a newly created profile by using the Acft // Profile Graphs function. If there is a problem with the profile, you can usually see it in the chart window much more easily than by examining the numerical data in the Profile Point window. You can change Profile Point data and see the profile change in the chart window.

If you have the same Profile (for example, DEP-S3) defined by both Profile Points and Procedure Steps, then Profile Points take precedence and are used in calculating the profile.

8.7.1. Distance

Distance is the horizontal distance value from a reference point. It can be positive or negative. You can think of distance as a value on the X axis, and the reference point is at X = 0. X always increases as the aircraft flies the profile. The reference point depends on the type of operation, as follows:

APP X=0 at the touchdown point. Before touchdown, distance X is negative; at touchdown the distance is zero; and after touchdown, the distance is positive.

DEP X=0 at the start-roll point. Distance values start at zero and become more positive.

TGO X=0 at the touchdown point. As with APP, the profile starts with negative distance; is zero at touchdown; and positive after that.

CIR X=0 at the start-roll point. Distance values start at zero and become more positive.

OVF X=0 at the desired starting point. Distance values start at zero and become more positive.

Notice that distance starts with negative numbers for approach and touch-and-go profiles.

8.7.2. Altitude

Altitude is altitude above field elevation (AFE), not altitude above sea-level, and not altitude above ground level. The altitude should be operationally realistic for the aircraft weight and airport temperature being modeled.

APP Altitude starts positive, then decreases to zero at the touchdown point, and remains zero thereafter.

DEP Altitude starts at zero, remains zero until takeoff, and increases thereafter.

TGO Altitude starts at the pattern altitude, decreases to zero at touchdown, remains zero until takeoff, and increases to the original pattern altitude.

CIR Altitude starts at zero, increases to pattern altitude, remains at pattern altitude, decreases to zero at the touchdown point, and remains zero thereafter.

OVF Altitude usually remains constant for the entire profile, although it does not have to.

8.7.3. Speed

Speed is true airspeed (TAS), not calibrated or indicated airspeed. The speed values must be operationally realistic so that sound exposures are properly modeled.

8.7.4. Noise Curve Type

Noise curve types are Normal and Afterburner. If you select Normal, you enter a thrust-setting value. If you select Afterburner, you choose an afterburner thrust-setting value from a drop-down list of available afterburner values per NPD data for the aircraft.

Thrust-setting versus distance is calculated differently for the two cases:

- Normal — INM draws straight lines from point to point. Thrust setting is linearly interpolated between points.

- Afterburner — INM inserts profile points to make thrust setting remain constant while the afterburner is on. For example, if you define a normal-afterburner-normal sequence of points, INM inserts two points: one normal point just before your afterburner point, and one afterburner point just before your normal point. The thrust-setting versus distance graph shows a sudden increase to the afterburner setting, and further on, a sudden decrease to the normal setting.

8.7.5. Thrust Setting

Thrust setting is used to access the NPD curves. For the INM aircraft, this parameter usually is the "corrected net thrust per engine" in pounds, but some aircraft use percent of static thrust. The NOISEMAP aircraft use all four types of thrust setting (pounds, percent, epr, other).

Thrust setting must be operationally realistic for the aircraft weight, altitude, temperature, and pressure being modeled. Make sure that this parameter and the thrust-setting identifiers for the aircraft NPD curves are compatible.

When the noise curve type is set to Afterburner, you select the afterburner curve by its thrust-setting identifier, rather than typing in the thrust-setting value.

8.7.6. Touch-and-Go Profile Points

If Profile Points are created properly, INM can adjust the points to fit them onto an arbitrary TGO track. This means that a TGO profile can be applied to different TGO tracks (just as an APP profile can be applied to different APP tracks).

The following list of profile points is an example of how to build a touch-and-go profile:

	DISTANCE	ALTITUDE	SPEED	THRUST
1	-11287.0	**900.0**	**116.5**	**50.22**
2	-10287.0	900.0	110.4	23.43
3	-6858.0	600.0	99.9	27.20
4	0.0	0.0	99.0	26.61
5	377.6	0.0	85.5	122.85
6	678.7	0.0	95.0	122.85
7	2883.1	226.6	115.4	101.98
8	7355.6	900.0	116.5	103.48
9	7605.6	**900.0**	**116.5**	**50.22**

For a TGO profile, you need to make the first and last points identical in altitude, speed, and thrust. INM can then insert extra distance between the last and first points to complete the TGO track

The distance around a TGO track must be larger than the last-point distance minus first-point distance in the profile. For example, a TGO track must be longer than 7605.6 – (–11287.0) = 18892.6 feet = 3.11 nmi for it to be used with the above profile.

8.7.7. Circuit Flight Profile Points

Likewise, a CIR profile can be applied to different TGO tracks. The following list of profile points is an example of how to build a circuit flight profile:

	DISTANCE	ALTITUDE	SPEED	THRUST
1	0.0	0.0	16.0	122.85
2	1584.5	0.0	95.0	122.85
3	3788.9	226.6	115.4	101.98
4	8261.4	900.0	116.5	103.48
5	**8761.4**	**900.0**	**116.5**	**50.22**
6	**8761.4**	**900.0**	**116.5**	**50.22**
7	10261.4	900.0	110.4	23.43
8	13690.4	600.0	99.9	27.20
9	20548.5	0.0	99.0	26.61
10	20737.3	0.0	93.9	40.00
11	22436.5	0.0	30.0	10.00

For a CIR profile, you need make two identical points somewhere in the middle of the profile (for example, points 5 and 6, above). INM can then insert extra distance to complete the TGO track between these two points.

In this example, the TGO track must be longer than the distance from start roll to touchdown in point 9, 20548.5 feet = 3.38 nmi.

8.7.8. Flight Path Construction

INM constructs a three-dimensional flight path by merging a two-dimensional profile (a set of distance vs. altitude points) with a two-dimensional ground track (a set of X,Y points) using the following method:

- Wherever there is a track point, a Z-value is computed by interpolating between two points on the profile.
- Wherever there is a profile point, X,Y values are computed on the ground-track segment under the profile point.

The result of this construction is an ordered set of X,Y,Z points and associated data describing the flight path. Thus, a flight path is a set of flight path segments, and each segment contains the following data:

- segment starting point (X,Y,Z)
- a unit vector pointing along the segment in the direction of flight
- segment length
- segment starting speed, and change in speed
- segment starting thrust-setting, and change in thrust-setting.

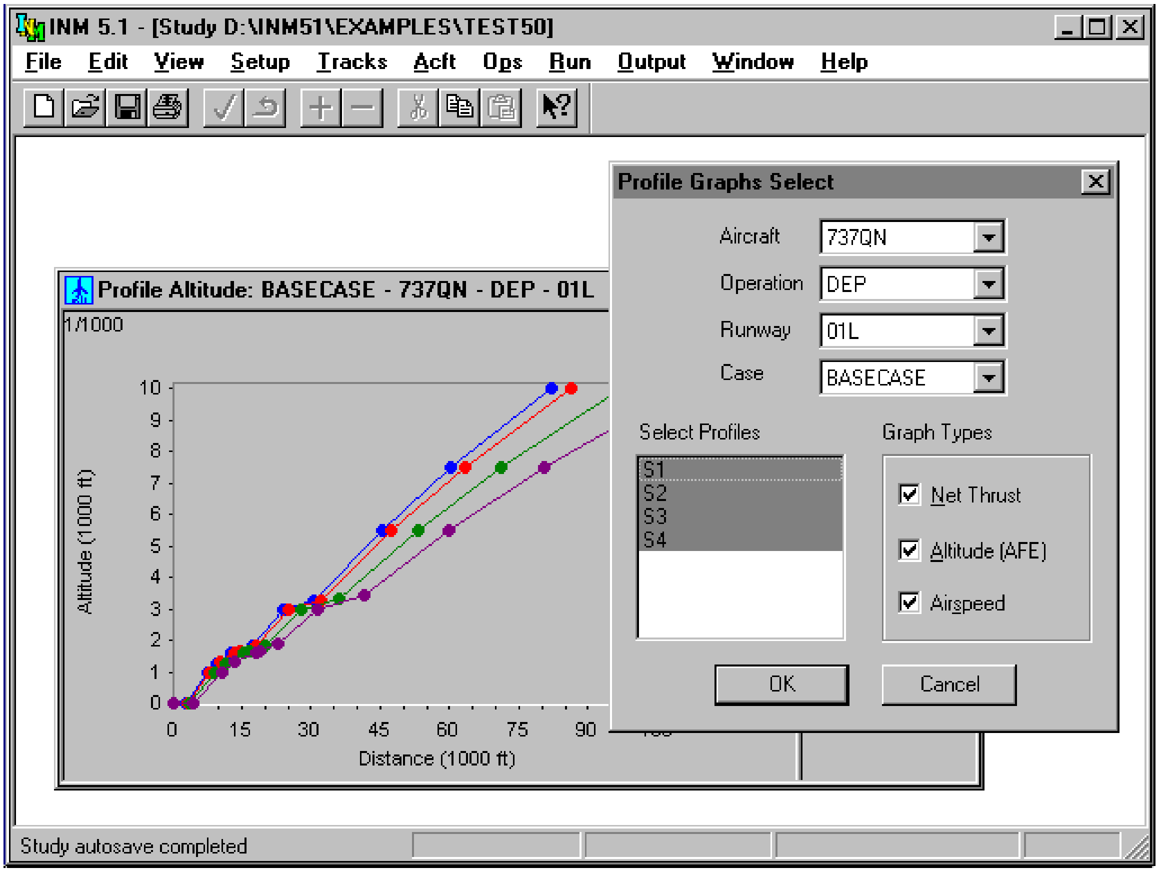
When performing this construction, INM automatically extends ground tracks so that a profile has a track under it. However, INM does not extend profiles, so the airplane "disappears" after the last flight path segment, and does not contribute to the noise calculation after that.

The last flight path segment is constructed by the following method:

- last segment starting point is the last profile point
- the unit vector is the same as the second-to-last segment unit vector
- last segment length depends on the type of operation: APP 100 ft, DEP 5 nmi, TGO 2 ft, CIR 100 ft, OVF 2 feet.
- last segment starting speed is the last profile speed, and change in speed is zero
- last segment starting thrust-setting is the last profile thrust-setting, and change in thrust-setting is zero.

For example, a DEP flight continues to climb after the last profile point at 10,000-ft altitude for another 5 nautical miles. An APP flight continues to taxi after the last profile point for another 100 feet. These parameters approximate the methods in INM 5.0.

The TGO last segment length is very small to prevent the touch-and-go path from being retraced. The OVF last segment length is very small so that you can specify the profile without INM adding to it.



8.8. Profile Graphs

Menu Item: Acft // Profile Graphs

You use this function to view three graphs:

1) altitude vs. distance
2) speed vs. distance
3) thrust vs. distance.

Select an Aircraft, type of operation, Runway End, and Case. INM pre-selects all the Profile records for the given Aircraft and operation type. Press "OK" to see all three graphs. If you want to limit the number of curves on the graphs, you can de-select some of the records before pressing OK. Also, you can limit the number of graphs (altitude, speed, or thrust).

You need to select a Runway End because computed profiles are adjusted for runway gradient and runway headwind. You need to select a Case because computed profiles depend on airport temperature, pressure, and headwind.

The first time you run this function, INM will take a while to read the Profile, Procedure Points, and Procedure Steps data from disk. After that, the Profiles are quickly computed and displayed.

Occasionally, you will see an error message about "Profile graph data could not be set up". To fix the problem, you need to select a Runway End that has a Track for the specified operation type. For example, if you created a TGO track on runway 17L, then to graph TGO or CIR profiles, you need to select 17L, not some other runway.

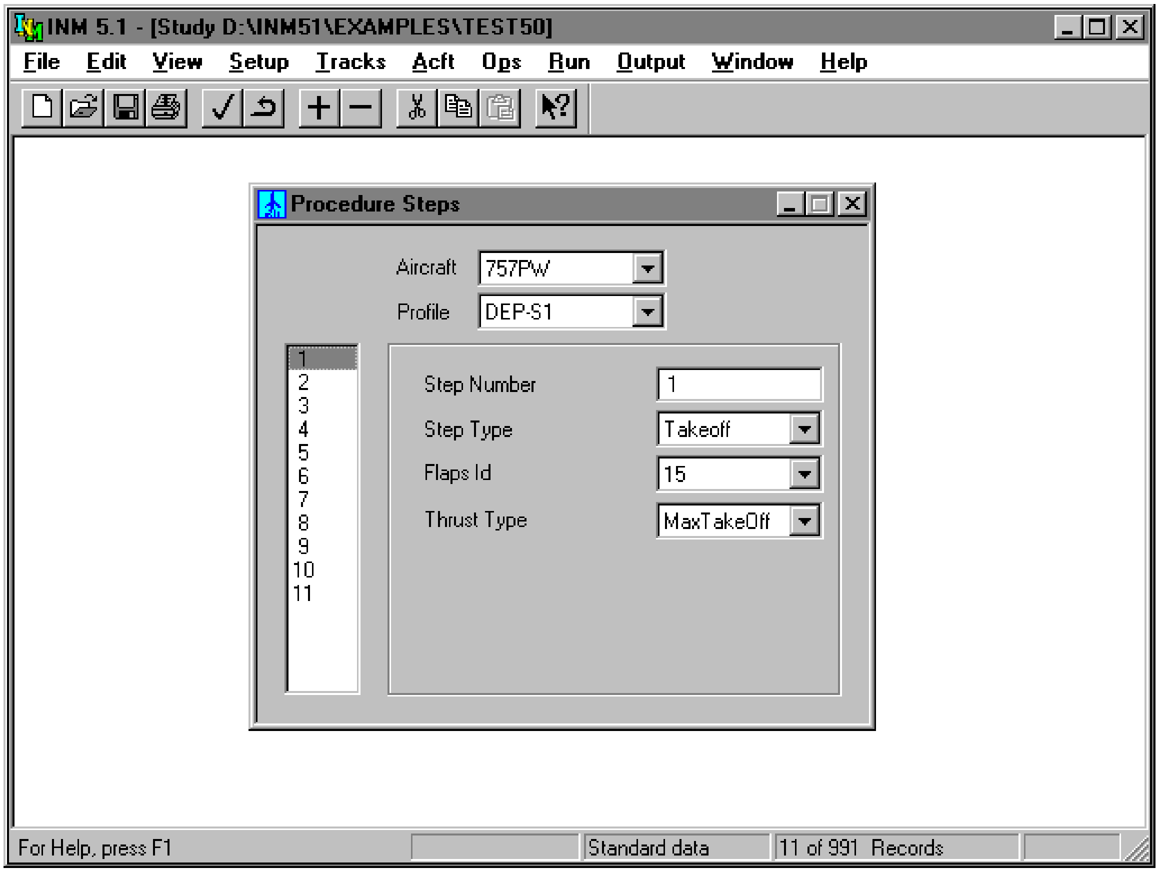
Occasionally, you will see an error message about "TGO track distance must be greater than TGO (or CIR) profile distance". To fix the problem, you need to make the TGO track larger, or change the profile so there is enough room for the airplane to fly at pattern altitude (see the suggested methods in Section 8.9.16).

The above error message can display for a track/profile combination that you do not intend to use in flight operations. For example, you plan to put piston aircraft in a 900-ft pattern on a small TGO track, and jets in a 1500-ft pattern on a large TGO track, and both tracks are on the same runway end. INM computes all profiles against all tracks for a given runway before displaying the graphs. So, a jet aircraft fails to compute on the small TGO track, and you see the above error message. To get the graphs to show, you can temporarily make the small TGO track bigger. When running a Case of flight operations, this problem does not occur because the flight operation determines the track/profile combination.

You can commit a record in the Procedure Steps or Profile Points window and immediately see the effect in the Profile Graph window. This feature is useful in debugging user-created Profiles.

There are three ways to get Profile Graph hardcopy:

- Use the File // Export As function to write profile-point data into a text file or DBF file.
- Use the File // Print function to send the graph to a printer.
- Use the Edit // Copy function to write a graphics metafile (WMF format) to the Windows Clipboard.



8.9. Procedure Step Data

Menu Item: Acft // Procedure Steps

Use this function to build profiles by defining operational procedures for various phases of the flight.

The advantage of using Procedure Steps (instead of Profile Points) is that your profiles are computed using Study and Case setup data (airport elevation, temperature, pressure, runway headwind and gradient). The disadvantage is that this is an advanced-user function, and it is not easy to use.

Most of the standard profiles in INM are computed using procedure-step data. The best way to learn how to create your profiles is to view and study standard Procedure Steps using this window.

Aircraft must have performance coefficient data (see Sections 8.10, 8.11, 8.12, below) before proceeding with Procedure Steps. Also, you need to declare a profile in the Profile window, as explained in Section 8.6. Then, in the Procedure Steps window, select the Aircraft and Profile that you plan to use.

General rules for the Procedure Steps window:

- Altitude is in feet (meters) above field elevation (AFE).
- Distance is in feet (meters) measured on the horizontal plane.
- Speed is in knots (km/h) and is calibrated airspeed (CAS), not true airspeed, or ground speed. Speed is used in calculating sound exposure. You must input realistic speed values, based on the operational situation being modeled.
- Descent and climb angles are in degrees and are both positive.

Always check a newly created profile by using the Acft // Profile Graphs function. If there is a problem with the profile, you can usually see it on the chart much more easily than by examining the numerical data in the Procedure Steps window. You can change Procedure Steps data and see the profile change in the chart window.

You can get a text file or DBF file of computed Procedure Step profile data by first using the Acft // Profile Graphs function to display the profile. Then, use the File // Export As function to create a file of profile point data.

8.9.1. Non-Standard Profiles

Aircraft performance coefficients that are used to calculate profiles are applicable to a sea-level airport and standard-day temperature profile (59 F at sea level). At high-elevation airports and/or hot temperatures, a few INM aircraft exhibit unrealistic performance; for example, BAE146 cannot climb out of Denver.

The problem is mainly caused by a negative G_b-coefficient multiplying the altitude-squared term in the jet thrust equation (see Section 8.11). For a few problem aircraft, computed thrust is too small at high altitude (measured from sea level), or at high temperature (which causes an equivalent high density altitude).

Small or negative calculated thrust causes the climb and acceleration equations to fail, and INM displays an error message about "not enough thrust". INM requires that an aircraft be able to climb at least 1 foot per 100 feet flown (climb angle of about 0.6 degrees). Even if INM does not display an error message, a profile could still be unrealistic.

If your airport is at high elevation, or if you have a hot temperature case (regardless of airport elevation), you need to check all the computed profiles, even the INM-standard ones. Unrealistic computed profiles must be replaced with profiles built from Profile Points.

8.9.2. Procedure Step Types

The five types of flight operations (APP, DEP, TGO, CIR, OVF) are created by using nine types of Procedure Steps:

1) Takeoff — Departure start-roll to takeoff rotation, or touch-and-go power-on point to takeoff rotation.

2) Climb — Departure climb to final altitude at constant calibrated airspeed.

3) Accelerate — Departure climb and accelerate to final speed.

4) Level — Maintain altitude and speed.

5) LevelStretch — Special step used to designate where to stretch a circuit flight profile to fit a touch-and-go track.

6) CruiseClimb — Climb at constant angle to final altitude.

7) Descend — Descend at constant angle to final altitude.

8) Land — Land and roll a given distance.

9) Decelerate — Brake with starting thrust for a given distance.

Appendix M shows the allowed transitions from one type of procedure step to the next, for each of the five types of flight profiles.

8.9.3. Takeoff Step

For a Takeoff step, you select a flaps identifier and a thrust type. The flaps identifier should <u>not</u> have a "U" or "D" prefix (even though you may think it makes sense to have the gear down when taking-off) because these coefficients were measured on descending flight paths.

You should usually select <u>MaxTakeoff</u> thrust for takeoff, but other thrust types are available.

<u>MaxClimb</u> thrust means that an aircraft takes off using reduced thrust, thus requiring a longer runway. If while running a Case, INM detects that an aircraft exceeds the runway length, INM displays a warning message about checking the FLIGHT.ERR file in the Case subdirectory, and then continues running the Case.

For MaxTakeoff and MaxClimb thrust, INM uses coefficients in the Jet Thrust (or Prop Thrust) window and SAE-AIR-1845 equations to compute thrust values. For jets, the start-roll thrust is computed using a reference value of 16 knots, and the rotation thrust is computed using the takeoff speed, which comes from another SAE equation. For jets, the thrust is larger at start-roll than at rotation. For props, the thrust is the same at both points and equal to the thrust computed at the rotation point.

UserValue thrust means that you supply the takeoff thrust value. The thrust value is the "corrected net thrust per engine" in pounds or in percent of static thrust. INM uses your input value at the start-roll point and at the rotation point.

8.9.4. Climb Step

For a Climb step, you select a flaps identifier, select a thrust type, and input the final altitude (the "climb-to" altitude). The final altitude must be higher than the initial altitude. The calibrated air speed on a climb segment is constant, and it is equal to the final speed used on the previous step.

INM computes the climb angle and the ground distance based on the average thrust that can be generated for the given aircraft weight.

You should usually select MaxTakeoff thrust for initial climb segments and MaxClimb for later climb segments, but other thrust types are available.

UserValue thrust setting is assigned to the final climb-to point. INM does not adjust this input value for airport elevation, temperature, and pressure, so you need to account for these airport conditions when you input the value.

You can also select UserCutback to input a thrust value. The difference between UserValue and UserCutback is that INM applies the user-value-thrust to a point, whereas user-cutback-thrust is applied to a segment. For the cutback case, INM reduces the thrust over a 1000-foot segment, keeps it constant at the user-cutback value over the climb distance (less 1000 feet), and then returns it to normal thrust over a second 1000-foot segment. The thrust is "corrected net thrust per engine", and INM does not adjust this value for airport conditions.

You can select ReduceThrust when building AC91-53A Noise Abatement Departure Profiles (NADPs). This thrust type works the same as UserCutback, except that INM computes the cutback value instead of you supplying it.

- If the Aircraft window has the Automatic Thrust Restoration System (ATRS) box checked, the thrust value is computed for a zero-climb gradient with one engine inoperative.
- If ATRS is not checked, the thrust is computed for one engine inoperative and a climb gradient that is in accordance with FAR Section 25.111(c)(3): 1.2% gradient for 2 engines, 1.5% for 3 engines, and 1.7% for 4 engines.

The aircraft for which you are building a ReduceThrust profile must have two or more engines. NADPs are used for turbojet aircraft with maximum gross takeoff weight of more than 75,000 pounds. INM does not produce error messages for engine type or aircraft weight not meeting these criteria because you may want to use the ReduceThrust option for other aircraft.

8.9.5. Accelerate Step

For an Accelerate step, you select a flaps identifier and a thrust type, and you input the climb rate and final speed (the "accelerate-to" speed). The final speed must be larger than the initial speed.

INM uses these input parameters and the SAE-AIR-1845 equations to compute the change in altitude and the distance flown.

The climb rate should be consistent with a sea-level standard-day profile. INM adjusts your climb rate to account for the actual airport elevation, temperature, and pressure.

Zero climb rate is a valid input. INM computes a zero change in altitude, and the thrust is used to accelerate the airplane more quickly.

The five climb thrust types discussed above for the Climb step (Section 8.9.4) are also available for an acceleration segment.

8.9.6. Level Step

For a Level step, you select a flaps identifier and input the altitude, speed, and distance flown along the segment. The flaps identifier should be "ZERO", or perhaps one with a "U" prefix (meaning that the landing gear is up).

You have to make sure that altitude and speed parameters make sense for segments before and after a Level segment. For example, a previous Climb final altitude must equal the Level altitude. Also, the Level altitude must equal the next Descend start altitude. INM catches most of these kinds of parameter mismatches when it tries to compute the profile. For each such problem, INM displays an error message and then stops the run.

INM computes the amount of thrust needed to maintain level flight at constant speed for the given flaps configuration.

The difference between a Level step and a zero-climb Accelerate step is that the Level step uses a constant speed on the segment, and it uses a smaller value of thrust (and thus, lower noise level) than the Accelerate step. If speed changes during level flight, use a zero-climb Accelerate step.

8.9.7. Level Stretch Step

For a Level Stretch step, you select a flaps identifier, and that is all. A Level Stretch step is only used for creating circuit flight profiles. Its purpose is to define where to put a variable-length segment so that a CIR profile fits on top of a TGO track.

There can be only one Level Stretch step in a CIR profile.

A Level Stretch step must have a Level step before it and after it. This pair of Level steps should have the same altitude and speed values.

8.9.8. Cruise Climb Step

For a CruiseClimb step, you select a flaps identifier (usually "ZERO"), and you input the final altitude, the climb speed, and the climb angle for the segment.

INM calculates the distance flown, based on the change in altitude and the climb angle. INM calculates the corrected net thrust per engine by using the SAE-AIR-1845 descent equation with a positive angle, rather than a negative angle.

The difference between Climb and CruiseClimb is that you select the thrust for Climb (by selecting MaxTakeoff, MaxClimb, etc.), whereas INM calculates thrust for CruiseClimb based on the input climb angle. Climb thrust is larger than CruiseClimb thrust. Climb steps are used after takeoff when near-maximum thrust is applied. During cruise, less thrust is used in climbing from one altitude to another.

8.9.9. Descend Step

For a Descend step, you select a flaps identifier and input the <u>starting</u> altitude, starting speed, and the descent angle for the segment.

If a Level or Descend step follows this Descend step, it must have a lower altitude. The following step can have the same or a different speed.

8.9.10. Land Step

For the Land step, you select a flaps identifier and input the touchdown rolling distance, which is the distance that the aircraft moves before reversing thrust and/or braking.

The last Descend step and the Land step must both use a flaps identifier that has a "D" prefix (meaning that the landing gear is down).

INM computes the touchdown speed by using the SAE-AIR-1845 equations.

8.9.11. Decelerate Step

For a Decelerate step, you input the segment distance, the starting speed, and the percent of static thrust at the start of the segment.

INM uses the percent value and the Aircraft static thrust to compute a thrust-setting for accessing the NPD curves. However, for those aircraft that use percent-type noise, the percent value is used to directly access the NPD curves.

8.9.12. How to Build an Approach Profile

You can use the Procedure Steps window to view standard approach procedures to see how to build new ones. INM standard approach procedures have four Descend steps, a Land step, and two Decelerate steps, as follows:

1) The four Decent steps start at 6000, 3000, 1500, and 1000 feet AFE. They bring an aircraft from zero-flaps configuration, terminal-area entrance speed, down to landing-gear/flaps configuration, final-approach speed.

   For those aircraft that would generally fly IFR approaches, a 3-degree descent angle is used. For single-engine piston aircraft and for BEC58P, a 5-degree descent angle is used to model VFR approaches.

2) For the Land step, the touchdown-roll distance is 10% of the total roll-out distance. For those aircraft using 3-degree approaches, the relationship between the total roll-out distance and the input parameter in the Aircraft window is:

   ```
   (Roll-Out Distance) = 0.9 (Maximum Landing Distance) - 954
   ```

   For those aircraft using 5-degree approaches, the 954-value is replaced with 572 feet (the angle is steeper, so the in-air portion of the flight path after crossing the end of the runway is shorter).

3) The first Decelerate distance is 90% of the total roll-out distance. The starting speed is a little less than the touchdown speed. The starting percent-thrust is 60% for jets and 40% for props. The first deceleration segment represents reverse thrust action.

4) The second Decelerate distance is zero, indicating the end of the profile (INM makes this segment 100 feet long). The starting speed is 30 knots, representing taxi speed. The starting percent-thrust is 10% of static thrust, representing taxi thrust.

8.9.13. How to Build a Departure Profile

You can use the Procedure Steps window to view standard departure procedures to see how to build new ones. INM standard departure procedures for jet aircraft tend to follow a pattern (but there are exceptions). A typical jet departure profile consists of the following procedure steps:

1) Takeoff using MaxTakeoff thrust and extended flaps.

2) Climb to 1000 feet using MaxTakeoff thrust and takeoff flaps.

3) Accelerate 10-20 knots using MaxTakeoff thrust, takeoff flaps, and 2/3 of the initial climb rate.

4) Accelerate 15-30 knots using MaxTakeoff thrust, reduced flaps, and 1/2 of the initial climb rate.

5) Accelerate to Vzf (zero-flaps minimum safe maneuvering speed) using MaxClimb thrust, minimal flaps, and 1000-fpm climb rate.

6) Climb to 3000 feet using MaxClimb thrust and zero flaps.

7) Accelerate to 250 knots using MaxClimb thrust, zero flaps, and 1000-fpm climb rate.

8) Climb to 5500 feet using MaxClimb thrust and zero flaps.

9) Climb to 7500 feet using MaxClimb thrust and zero flaps.

10) Climb to 10000 feet using MaxClimb thrust and zero flaps.

A standard departure profile for propeller-driven aircraft also tends to follow a pattern of procedure steps:

1) Takeoff using MaxTakeoff thrust and takeoff flaps.

2) Accelerate 10-15 knots using MaxTakeoff thrust, takeoff flaps, and a standard rate of climb.

3) Climb to 1000 feet using MaxTakeoff thrust and takeoff flaps.

4) Accelerate to Vzf using MaxTakeoff thrust, takeoff flaps, and a standard climb rate.

5) Climb to 3000 feet using MaxClimb thrust and zero flaps.

6) Climb to 5500 feet using MaxClimb thrust and zero flaps.

7) Climb to 7500 feet using MaxClimb thrust and zero flaps.

8) Climb to 10000 feet using MaxClimb thrust and zero flaps.

A standard Aircraft usually has more than one departure profile. Longer trips require more fuel, making an aircraft heavier and the profile lower. INM profiles are distinguished by stage lengths, which are numbered from 1 to 7. In the Profile window, a standard Profile is indicated by an "S" for the group identifier, and by "1" to "7" for the stage number.

Departure Procedure Steps are almost the same for all stage lengths. Usually, the only change is in the Vzf value, which increases for heavier aircraft. Sometimes, the climb rate for an Accelerate step is reduced for heavier aircraft.

8.9.14. How to Build a Close-In NADP

An INM standard departure procedure can be used to create a Close-in NADP that conforms to FAA Order AC91-53A. The following method is <u>not</u> an official method. It is your responsibly to coordinate with the FAA before using NADP profiles for environmental impact studies.

1) Create a new departure Profile record with identifier "C" for Close-in. Use standard stage and weight.

2) Copy standard departure Procedure Step records and paste them into the new profile (usually 9 or 10 records).

3) In the new profile, change step-2 altitude from 1000 to 800 feet.

4) For step 3, Climb to 3000 feet using ReduceThrust and takeoff flaps.

5) For steps 4, 5, and 6, Accelerate in increments to Vzf using MaxClimb thrust. Use the same schedule for flaps and climb rate as used in the standard Procedure Steps. You may have to reduce the first two climb rates because MaxClimb thrust may not be large enough to accelerate and climb at the given rate.

6) For steps 7, 8, and 9, Climb in increments to 10000 feet using MaxClimb thrust. Use the same altitude schedule as in the standard Procedure Steps (5500, 7500, 10000 feet).

8.9.15. How to Build a Distant NADP

An INM standard departure procedure can be used to create a Distant NADP, in a manner similar to the Close-in NADP discussed above (Section 8.9.14).

1) Create a new departure Profile record with identifier "D" for Distant. Use standard stage and weight.

2) Copy standard departure Procedure Step records and paste them into the new profile (usually 9 or 10 records).

3) In the new profile, change step-2 altitude from 1000 to 800 feet.

4) Change step-6 (sometimes step-5) MaxClimb to ReduceThrust, and Climb to 3000 feet using ReduceThrust and zero flaps.

5) Leave all other steps as they are.

Appendix L shows examples of Close-in and Distant NADPs.

8.9.16. How to Build a Touch-and-Go Profile

You need to create two profiles to model a complete touch-and-go operation. To model the touchdown and takeoff operation, use the procedures below. To model departure into, and approach from, the touch-and-go pattern, see Section 8.9.17 below.

1) The first step is Level at the pattern altitude and at a speed consistent with your choice of flaps. Use a small value for the distance parameter (for example, 500 feet).

2) Add one or more Descend steps using a flaps/speed schedule that ends with landing flaps, gear down, and final approach speed.

3) Land using a touchdown roll distance that represents the distance traveled before power is applied to takeoff again.

4) Takeoff using MaxTakeoff thrust, takeoff flaps, and a starting power-on speed that is 10-20 knots less than the touchdown speed. INM computes the distance needed to accelerate from power-on speed to takeoff speed.

5) Climb (or Accelerate and Climb) to pattern altitude in a manner similar to a departure procedure.

6) If necessary, Accelerate with zero climb rate at pattern altitude to the speed used in the first step.

7) The last step is Level at the pattern altitude at the speed used in the first step. Make this segment 1000 feet long (it will be divided into two 500-foot segments when INM detects the discontinuous change in thrust from the Accelerate step to the Level step). INM creates a Level segment on the down-wind leg that connects the Level departure segment (this last step) to the Level approach segment (the first step).

Always check your profile by using the Profile Graph function.

When you try to test the touch-and-go profile by looking at it in the Profile Graph function, you may see an error message about the TGO profile being too long for the TGO track. If you are sure that the ground track is realistically sized, you need to change the profile. You have several options for shortening a profile:

- Make the two Level-step distance parameters smaller.
- Make the descent angle slightly larger (for example, change 3.0 to 3.5 degrees).
- Use MaxTakeoff thrust instead of MaxClimb thrust.
- Reduce the airplane weight so that it climbs to pattern altitude in less distance (make sure that both TGO and CIR weights are the same).
- Lower the pattern altitude, if operationally realistic.

The INM database contains touch-and-go and circuit flight profiles for all aircraft that have performance coefficients for both approach and departure. These TGO and CIR database profiles are not considered "standard". Instead, they are generic profiles that you should modify for specific airport operational conditions. Also, you can view these profiles as examples for how to build your own TGO and CIR profiles.

The INM database touch-and-go and circuit flight profiles were developed using the following criteria:

- Profiles are designated TGO-S1 and CIR-S1.
- TGO and CIR profile weight is standard stage-1 departure weight.

- Pattern altitude for small piston aircraft is 900 feet and for all other aircraft is 1500 feet AFE.

- Pattern speed is the standard stage-1 departure accelerate-to speed for the first acceleration segment.

- Pattern flaps are the standard stage-1 departure flaps for the first acceleration segment.

- Decent angle for small piston aircraft is 5 degrees and for all other aircraft is 3 degrees.

- Approach speeds are scaled to profile weight.

- TGO landing roll distance, before applying takeoff power, is twice the standard approach roll distance before applying reverse thrust.

- TGO power-on speed is the smallest of: 95% of the landing speed, the standard approach decelerate speed, or 90% of the takeoff speed.

- CIR deceleration steps are the same as standard approach steps.

8.9.17. How to Build a Circuit Flight Profile

You need to create two profiles to model a complete touch-and-go operation. To model departure into, and approach from, the touch-and-go pattern, use the procedures below. To model the touchdown and takeoff operation, see Section 8.9.16 above.

1) Takeoff using MaxTakeoff thrust and takeoff flaps.

2) Climb (or Accelerate and Climb) to pattern altitude in a manner similar to a departure procedure.

3) If necessary, Accelerate with zero climb rate at pattern altitude to the speed used in the first step of the TGO procedure.

4) Add a Level step using pattern altitude, speed, and flaps that were used in the TGO procedures. Use a small value for the distance parameter (for example, 500 feet).

5) Add a Level Stretch step using the TGO flaps identifier. INM calculates the distance that is added to the profile so it fits the TGO track.

6) Again add a Level step at pattern altitude and speed. Use a small value for the distance parameter.

7) Add one or more Descend steps using a flaps/speed schedule that ends with landing flaps and final approach speed.

8) Land using a touchdown distance that represents the distance traveled before reverse thrust is applied.

9) Add two Decelerate steps in a manner similar to the approach procedure.

A circuit flight must have one, and only one, Level–LevelStretch–Level sequence of steps. The two Level steps must be at the same altitude and speed. All three steps should use the same flaps identifier.

Always check your profile by using the Profile Graph function. In doing so, you may find that a circuit flight profile is too long for a TGO track. You can modify your profile by using options discussed above in Section 8.9.16.

The INM database contains generic circuit flight profiles, as discussed above in Section 8.9.16.

8.9.18. How to Build an Overflight Profile

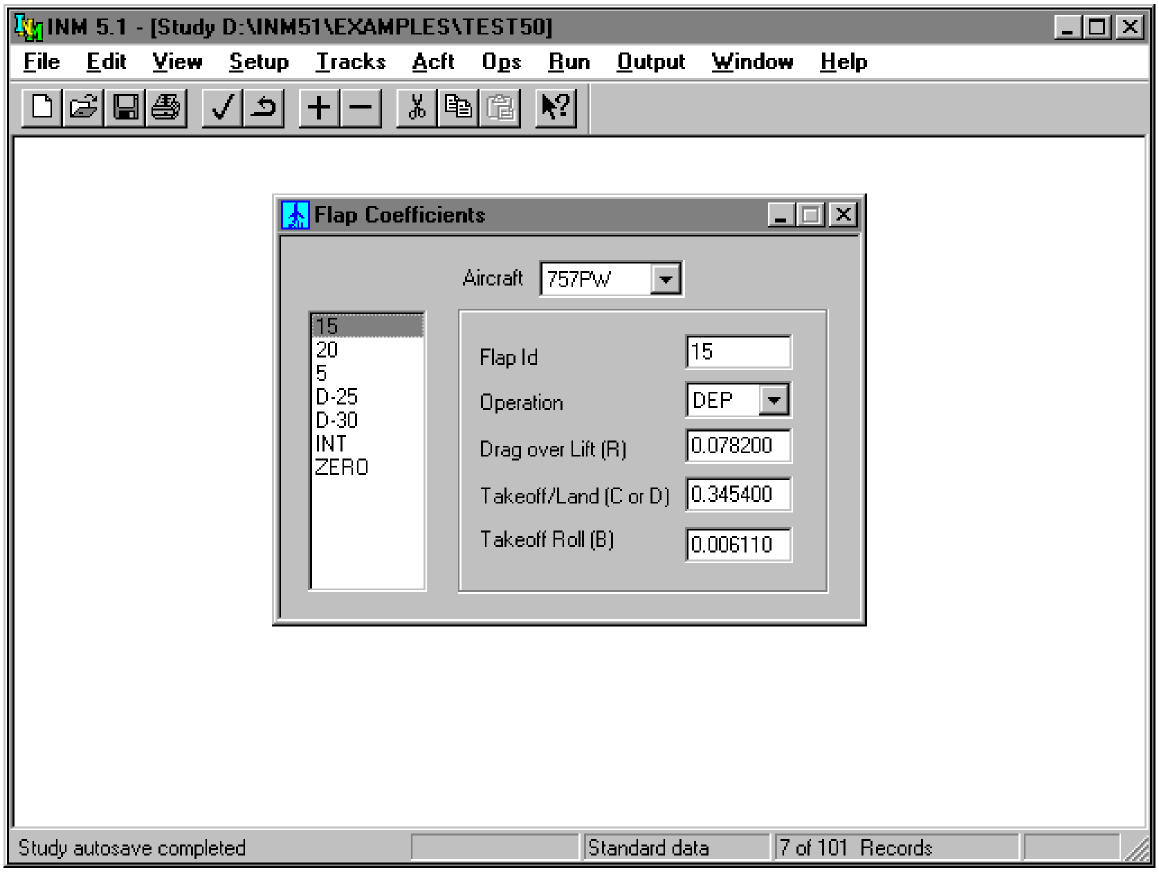
An overflight profile can be as simple to build as creating a single Procedure Step. For example:

- Level using "ZERO" flaps, at 5000-ft altitude, at 250 knots, for a distance of 300,000 feet (about 50 nmi).

Make sure that an overflight profile is long enough so it can go from one side of the terminal area to the other. The associated OVF track should start outside of the terminal area and cut across it.

8.9.19. Flight Path Construction

INM calculates profile points using Procedure Step data and SAE-AIR-1845 equations. After profile points are calculated, a three-dimensional flight path is constructed by the method described above in Section 8.7.8.



8.10. Flaps Coefficients

Menu Item: Acft // Flap Coeff

You should not change or add Flap Coefficient records. These empirical data are derived from measurements of actual aircraft flight dynamics or from manuals and handbooks containing measured data, usually by the manufacturer. If you want to derive coefficients, you need to follow the procedure described in SAE-AIR-1845 (see Appendix A for how to obtain this document).

If you accidentally change or add records, "User data" appears on the status bar at the bottom of the main window. You can delete these user-generated records, one by one, or you can get into the File Manager and delete the entire FLAPS file from your Study directory. Either way, INM will use standard coefficients the next time you open the Study.

Many standard Aircraft do not have flap coefficients. INM supplies standard Profile Point data for some of these Aircraft. NOISEMAP Aircraft do not have flap coefficients or Profile Points.

Flap coefficients depend on the type of operation (approach or departure) and the flaps and gear configuration of the Aircraft.

- The number in the flaps identifier usually means the number of degrees that the flaps are extended.

- Some approach identifiers have the prefix "U", meaning that the gear is up during descent; the prefix "D" means that the gear is down.

- Sometimes a departure flaps identifier is used in an approach Procedure. The "ZERO" flaps identifier is often used in both departure and approach Procedures, even though it is categorized as a departure identifier. "ZERO" means that the flaps are completely retracted.

The drag-over-lift R-coefficient is used in SAE-AIR-1845 equations involving departure climb and acceleration.

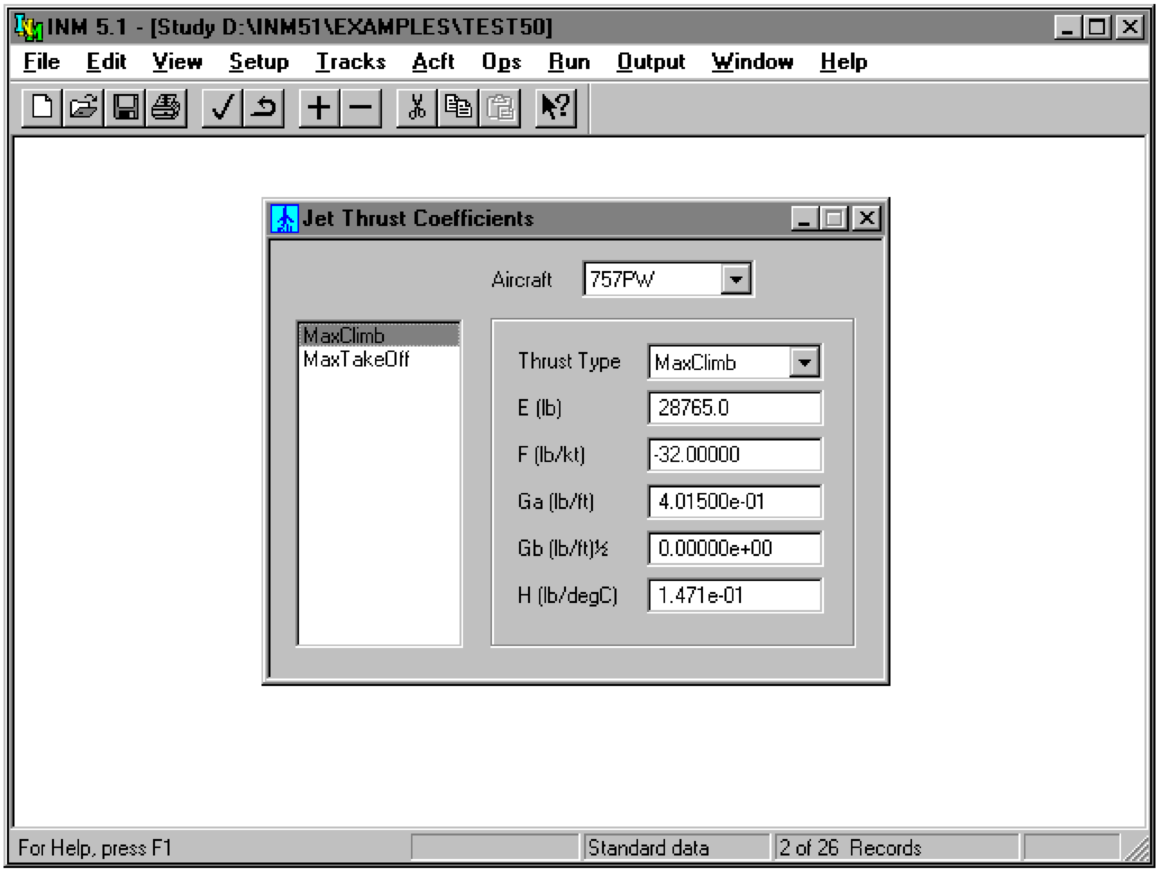
The takeoff-speed C-coefficient and the landing-speed D-coefficient are used to calculate speed as a function of the square-root of the aircraft weight:

$$\text{Takeoff} \quad V_C = C \, \mathrm{sqrt}(W)$$
$$\text{Landing} \quad V_C = D \, \mathrm{sqrt}(W)$$

Where V_C is the calibrated airspeed in knots, sqrt( ) is the square root function, and W is the aircraft weight in pounds.

Flap identifiers with the prefix "D" are D-coefficients, and the others are C-coefficients. Notice that some of the C/D coefficients are zero. This means the flaps identifier <u>cannot</u> be used for takeoff or landing Procedure Steps.

The takeoff-roll B-coefficient is used to calculate the takeoff distance in a SAE-AIR-1845 equation. The B-coefficient is in units of feet per pound. A variation of the SAE equation is used for touch-and-go takeoff distance.



8.11. Jet Thrust Coefficients

Menu Item: Acft // Jet Coeff

You should not change or add Jet Thrust Coefficient records. These empirical data are derived from measurements of actual aircraft flight dynamics. If you want to derive coefficients, you need to follow the procedure described in SAE-AIR-1845.

There are usually two Jet Thrust Coefficient records per Aircraft, one for MaxTakeoff thrust and one for MaxClimb thrust. One aircraft (727QF) has three records; the third thrust type is called MaxContinue for "maximum continuous" thrust.

Many standard Aircraft do not have thrust coefficients. INM supplies standard Profile Point data for some of these Aircraft. NOISEMAP Aircraft do not have thrust coefficients or Profile Points.

You need to input three of the coefficients (G_a, G_b, H) in scientific notation (for example, "1.223e-5", meaning 1.223 10^{-5}) because their values are either very small or cover a large range.

Jet Thrust Coefficients (E, F, G_a, G_b, H) are used to calculate "corrected net thrust per engine" by using the equation:

$$F_n/\delta \;=\; E + F\,V_c + G_a\,A + G_b\,A^2 + H\,T$$

Where F_n is net thrust per engine in pounds, δ is the ratio of the atmospheric pressure to the sea-level standard value, V_C is calibrated airspeed in knots, A is pressure altitude in feet MSL, and T is temperature in degrees Celsius.

8.12. Prop Thrust Coefficients

Menu Item: Acft // Prop Coeff

You should not change or add Prop Thrust Coefficient records. These empirical data are derived from measurements of actual aircraft flight dynamics. If you want to derive coefficients, you need to follow the procedure described in SAE-AIR-1845.

Prop Thrust Coefficients are used to calculate "corrected net thrust per engine" by using the SAE-AIR-1845 equation:

$$F_n/\delta \;=\; (325.87\,E\,P\,/\,V_T\,)\,/\,\delta$$

Where F_n is net thrust per engine in pounds, δ is the ratio of the atmospheric pressure to the sea-level standard value, E is propeller efficiency, P is net propulsive (shaft) power per engine at sea level in horsepower, and V_T is true airspeed in knots.