2. INTRODUCTION

This section introduces INM by discussing how the INM model is supposed to be used and summarizing enhancements made to this version. It also gives an overview of the software interface between you and the model, and describes the contents of the INM51 disk directory.

2.1. INM Use

The Federal Aviation Administration, Office of Environment and Energy (AEE-120) currently provides Version 5.1 of the Integrated Noise Model (INM) for evaluating aircraft noise impacts in the vicinity of airports. Various versions of the INM computer program have been used since 1978 by over 700 organizations in 35 countries.

INM has many analytical uses, such as assessing changes in noise impact resulting from new or extended runways or runway configurations, assessing new traffic demand and fleet mix, assessing revised routings and airspace structures, assessing alternative flight profiles, and assessing modifications to other operational procedures. The model is typically used in the U.S. for FAR Part 150 noise compatibility planning and FAA Order 1050 environmental assessments and environmental impact statements.

2.1.1. INM is an Average-Value Model

INM 5.1 aircraft profile and noise calculation algorithms are based on the SAE-AIR-1845 methodology, as were previous versions of INM. See Appendix A for information on how to obtain the SAE-AIR-1845 report.

INM is not a detailed acoustics model in that it does not model user-input temperature profiles, wind gradients, humidity effects, ground absorption, individual aircraft directivity patterns, and sound diffraction around terrain, buildings, barriers, etc. INM is an average-value model and is designed to estimate long-term average effects using average annual input conditions. Because of this, differences between predicted and measured values can sometimes occur because important local acoustical variables are not averaged, or because they may not be explicitly modeled in INM.

2.1.2. Average Annual Day

In the U.S., annual day-night average sound level is used for quantifying airport noise. The Federal Aviation Regulation (FAR) Part 150 definition of this quantity is:

- Yearly day-night average sound level (Part 150 Sec. A150.205(c)) "(YDNL) means the 365-day average, in decibels, day-night average sound level. The symbol for YDNL is also L_{dn}. It is computed in accordance with the following formula:

  $$L_{dn} = 10 \log((1/365) \Sigma 10^{L_{dni}/10})$$

  where L_{dni} is the day-night average sound level for the i-th day out of the year." The summation is from i = 1 to 365.

If you were to use this definition to model noise in INM, you would have to run 365 cases of the model and average the results! Instead, INM uses the concept of an "average annual day". FAR Part 150 allows the use of average input data in INM, as follows:

- Operational data (Part 150 Sec. A150.103(b)) "...the following information must be obtained for input to the calculation of noise exposure contours: ... (2) Airport activity and operational data which will indicate, on an *annual average-daily-basis*, the number of aircraft, by type of aircraft, which utilize each flight track, in both standard daytime (0700-2200 hours local) and nighttime (2200-0700 hours local) periods for both landings and takeoffs."

An average annual day is the user-defined best representation of the typical long-term conditions for the case airport. These average conditions include the number and type of operations, routing structure, runway configuration, and temperature.

It may be useful or necessary to perform supplemental analysis for different times of the year or other time periods. For example, a supplemental analysis may be necessary for the spring season as compared with fall and winter, if significant changes in fleet mix, flight operations, or flight tracks are anticipated.

2.1.3. Using the INM Model

Important INM modeling issues and requirements are listed below:

1) If you are doing FAR Part 150 or FAA Order 1050 EIS studies, the FAA must approve any changes or additions that you make to the INM standard aircraft, noise, or profile data. Please refer to Appendix A for the FAA point-of-contact person and Appendix B for the checklist of items needed for FAA approval.

2) Contact the FAA for AC91-53A Noise Abatement Departure Profile (NADP) approval. INM 5.1 does not contain pre-approved NADPs, even though suggested profile procedures for NADPs are presented as examples.

3) INM was not designed for single-event noise prediction, but rather for estimating long-term average noise levels using average input data. Comparisons between measured data and INM calculations must be considered in this context.

4) Make every effort to develop accurate average values for input data. In particular, flight profiles and tracks must be modeled realistically. In INM 5.1, you have the capability to adjust average aircraft profile weight directly (instead of using the stage length surrogate), so that a more accurate representation of flight operations can be made by using actual averages of takeoff weights.

5) Do not automatically use INM standard data. These data are generic and may not realistically represent flight operations at your airport. For example, Air Traffic Control at large airports typically directs aircraft to climb to and maintain specific altitudes before climbing further (for the purpose of threading traffic flows). Standard INM departure profiles have aircraft climb continuously to 10,000 feet above field elevation, and these generic profiles would be inappropriate to use in such a situation.

6) Be careful when using INM procedure-step computed profiles in non-standard conditions. The INM database of SAE-AIR-1845 performance coefficients was developed for aircraft using a sea-level airport at a standard-day temperature of 59 F. At higher elevations and/or temperatures, some computed profiles are not realistic because variables used in equations to calculate engine thrust and profile geometry are out of bounds (for example, BAE146 computed thrust is too low for Denver). When doing studies of high-elevation airports or for non-standard temperatures, you need to double check all profiles that are derived from procedure-steps, and if necessary, substitute your own realistic profile points for those aircraft that do not seem to perform as expected.

7) Be careful when using OAG-derived flight operation data. In the OAG, a single real flight may be entered multiple times under different airline names (the practice of "code sharing"). Also, you should review warnings in the output log file, where you may find missing airports, missing equipment types, and/or incompatible stage lengths. Remember that OAG data represents only scheduled commercial flights, and that you need to add unscheduled commercial, general aviation, and military flights.

8) Do not change or add aircraft performance coefficients unless you follow procedures in SAE-AIR-1845 and use valid source data based on measured data or flight manuals.

2.1.4. Using the INM Computer Program

The following items are of importance in using the INM computer program.

1) If you create your own profiles, either by using profile points or procedure steps, always view the profile using the Acft // Profile Graph function to double check your work before trying to calculate contours.

2) If you create your own input DBF files outside of INM (for example, with a spreadsheet), make sure that key fields in related files are correct. For example, the key fields in the TRK_SEGS file (runway end identifier, operation type, and track identifier) must map exactly to the key fields in the TRACK file.

3) Check INM-supplied latitude/longitude values for the airport reference point, runway end points, navaids, and fixes.

4) Do not use the File Manager or the Explorer to rename or delete Case or Output subdirectories. Let INM manage these Study subdirectories.

2.2. INM 5.1 Enhancements

This section summarizes some important enhancements made to INM 5.1. Appendix D lists the enhancements in detail. Enhancements made when going from the DOS version 4.11 to the Windows version 5.0 were documented in the INM 5.0 User's Guide, and they are reproduced in Appendix E.

1) INM 5.1 runs under the Windows 95, NT 3.51, or NT 4.0 operating systems. INM 5.1 <u>does not run under Windows 3.1</u> or Windows for Workgroups. Both Windows 95 and NT are multitasking operating systems. You can switch to another program while INM is running a case. An INM run will not lock-up the computer, as it did on the Windows 3.1 operating system.

2) The database is updated. There are now 216 aircraft in INM 5.1.

   Two aircraft/engine configurations of the MD90 aircraft (identifiers MD9025 and MD9028) are added to the database.

   U.S. Air Force NOISEMAP aircraft are now in INM. NOISEMAP aircraft are indicated by "NM" at the end of the aircraft description field, and noise is indicated by "NoiseMap" in the model-type field.

NOISEMAP aircraft do not have performance coefficients, nor do they have profile points data. You will need to create your own profiles, via the Profiles and Profile Points windows, to use NOISEMAP aircraft in INM studies.

The standard noise data for the DHC8 and DHC830 aircraft are modified so that extrapolation to unrealistically small or large noise levels is avoided. As a result, approach noise is increased and departure noise at start-roll is reduced.

The 72710A and 72720A aircraft, which were INM standard aircraft in previous versions of INM, are moved to the USR_DATA subdirectory. These two aircraft and their profile data were removed from the database because they do not have standard noise data.

3) Many DBF file formats are changed to support various model enhancements. These DBF format changes are documented in Appendix H. If you developed a computer program to create DBF files for input into INM, you may have to modify your software to conform to the new format. INM 5.1 automatically converts your INM 5.0 Studies to the new format.

4) The takeoff noise algorithm is corrected, smoothing out contours at 90 degrees to the runway at the start-roll point. This correction increases noise levels in back of the runway about one decibel or less.

The touch-and-go noise algorithm is corrected, smoothing out contours extending out from the runway. This correction reduces touch-and-go noise along the runway but not in the pattern.

5) There is extensive support for touch-and-go operations. The INM 5.1 database contains generic touch-and-go Procedure Steps for all aircraft that have performance coefficients. (Note that 15 INM aircraft and all NOISEMAP aircraft do not have performance coefficients.)

There are two kinds of touch-and-go profiles. The TGO-type starts at pattern altitude, descends, lands without stopping, takes off, and climbs back to pattern altitude. A new type of profile, called CIR for "circuit flight", starts with takeoff roll, takes off, climbs to pattern altitude, descends, lands, and decelerates to taxi speed.

The two profile types (TGO and CIR) are both used with a single TGO-type track. Thus, a complete touch-and-go operation can now be created with just three objects (2 profiles and 1 track), rather than the six objects previously needed (3 profiles and 3 tracks). You may need to adjust the standard database profiles for actual airport conditions, such as touch-and-go pattern altitude, but they will provide a much easier way of creating a study containing touch-and-go operations.

6) Geographic information system (GIS) programs are better supported. All latitude/longitude input and output data are now in decimal-degree format, rather than degree-minute-second format. North latitude and east longitude are positive, and degrees are written to six decimal places, conforming to common GIS format.

   Location points input, population points input, standard analysis grid output, and contour points output DBF files can be imported into GIS programs for display. Also, the Files // Export As function for runways, points-type tracks, and grids supports the lat/long format, so that these data can be imported into a GIS program.

   Two related changes are (1) runway end points are now input in x/y format, rather than lat/long format; and (2) under the View menu there is a Lat/Long Calculator dialog that lets you to convert lat/long to x/y, and vice versa.

7) There are enhancements to Input and Output Graphics functions: CAD drawings can be displayed in Input Graphics. An Output Graphics window can be viewed without first running a case. Two output windows can be set to the same scale for comparative viewing. Printing is based on printer-supplied print area for more accurate scale setting. User-defined text can be placed on output graphics. Output to a DXF file is in colored layers.

8) There are other miscellaneous improvements: Various bugs in version 5.0 have been fixed. Procedure Step parameters are more thoroughly checked for input errors. Profile Point data can be exported in table format. Case copy works better. The View Ops Filter function is easier to use. Airport runways, navaids, and fixes are updated using new NFDC data. Value ranges for various parameters are increased (for example, 999 points per track are now allowed).

9) The Source Data Processor (PREPROC.EXE) is modified. The Convert 4.11 processor is upgraded to handle touch-and-goes and run-ups better, and the processor now runs much faster. The Census processor is modified to read both Tiger 94 and 95 CD-ROMs, and to include state and county numeric codes on population-point census block identifiers. The DXF processor can now convert AutoCAD R13 files, except for the curved-line format (arc-line-arc). Two of the processors are moved into a new INM Files // Import function: the Text-to-DBF processor, and the Text-to-Radar processor.

2.3. User/System Interface

You interact with the INM system when you process source data, prepare input data, execute the model, and analyze output data. To facilitate user/system interface tasks, INM provides various ways to work with data, including two menu-driven Windows computer programs.

2.3.1. Graphical User Interface

INM 5.1 uses Microsoft Windows graphical user interface system for data input, model execution, and data output. Windows provides a very different way of interacting with INM than that used in previous DOS versions. Instead of preparing a free-form input file with a text editor, you now fill out boxes in data-input forms in windows on the screen.

Often the input data are selected from lists provided by INM, making the data-entry job less error prone. INM validates data as you commit each record, so an INM Study data set is built up as an integrated whole.

INM 5.1 uses color and graphics to help you visualize input data. It provides graphs of noise-power-distance curves and aircraft profile data, and lets you input tracks by pointing and clicking with a mouse.

2.3.2. Data File Interface

INM 5.1 is designed to be used with other software tools. Most of the input and output files are in dBase-IV format (they have DBF file extension). This is very useful because you can use a DBMS program to input and manage large files (especially the Flight Operations file), and you can use "spreadsheet" programs to create presentation graphics of output data.

These tools are not required to run INM, and they are not considered part of INM, but for large Studies, they can be useful. Some programs that directly read and write DBF files are:

Borland® dBase for Windows® DBMS
Borland® Paradox for Windows® DBMS

Microsoft® Access for Windows® DBMS
Microsoft® Fox Pro for Windows® DBMS
Microsoft® Excel for Windows® spreadsheet
Novell® Quattro Pro for Windows® spreadsheet
Lotus® 1-2-3 for Windows® spreadsheet

Please be careful when using these programs so that you do not accidentally change the DBF format of an INM file, in particular the field width. Some spreadsheets change the field width when you simply change the visual appearance of the data on the screen and then save the file. INM cannot read a DBF file that has its format changed.

Because INM now uses public DBF files (rather than secure, but inaccessible binary files), it must employ strong data validation processing to maintain the integrity of the DBF files in memory. Data checking is performed on each record as DBF files are read from disk. This requires extra processing time, and you will notice a few seconds delay, especially for large files.

2.3.3. Input/Output Capabilities

INM input capabilities:

- Enter data interactively in various DBF form-input windows.
- Enter track data interactively in the input graphics window.
- Use an old INM input text file and convert it with an INM- supplied program.
- Create text files and use an INM-supplied text conversion import function.
- Use a DBMS or spreadsheet program and directly create DBF input files.

INM output capabilities:

- View output charts, graphics, and tables on the screen.
- Print charts, graphics, and tables on a printer or to print files (for example, Postscript).
- Copy tables and charts to the Microsoft Clipboard for use in other applications.
- Export tables to DBF files or text files using a fixed-column or comma-quote format.
- Directly access DBF output files using a DBMS or spreadsheet program.

INM does not support Object Linking and Embedding (OLE) methods of exchanging data with other programs.

2.3.4. INM Main Menu

The INM.EXE program displays a menu of functions that lets you manage your Study, input data, run the model, and display the results. The main menu functions are introduced below, and they are discussed in detail in Sections 3 through 13.

File	Create new study, open old study, import data, export data, print, and exit.
Edit	Add, delete, copy data records, and edit graphics data.
View	Control the appearance of graphics displays, and calculate lat/longs.
Setup	Setup study, aircraft, substitutions, metrics, cases, and location points.
Track	Input runways and tracks, and do graphical editing.
Acft	Input aircraft, substitution, noise, and profile data.
Ops	Input and calculate flight and run-up operations.
Run	Setup analysis grids and run options, run batches of cases.
Output	Setup output data, view contours and tables, make echo report.
Window	Control the appearance of windows.
Help	Access help information.

2.3.5. Source Data Processing Menu

The PREPROC.EXE program displays a menu of functions that runs modules within the program or separate computer programs. These modules/programs are used to process source data for input to INM. The Source Data Processing menu functions are introduced below, and they are discussed in detail in Section 14.

INM4.11	Convert a FOR02.DAT input file into INM 5.1 format.
Terrain	Make an airport-centered file of terrain elevation data, and create a graphics terrain contours file.

Census	Make a street map graphics file, a population graphics file, and do various population file conversions.
OAG	Make an input file of scheduled flight operations using OAG data.
DXF	Convert a DXF file into INM graphics format.
Help	Access help information.

2.4. INM51 Disk Directory

The INM 5.1 system software is contained in various disk directories, as briefly described below. Appendix F lists the files contained in the INM system directory, and Appendix G lists the files contained in a typical Study directory.

1) **INM51** — This is the main system directory. It contains user-interactive programs, their supporting dynamic link libraries (DLLs), help files, and system subdirectories — everything needed to run INM. You interact with two Windows programs: INM.EXE is the main input-run-output program; and PREPROC.EXE is the supporting source-data-processing program. You can rename this directory, if you wish, but use the 8-dot-3 DOS naming convention.

2) **COMP50** — This system subdirectory contains the noise calculation module. COMP50.EXE writes the recursively-subdivided grid noise files, GRID and CONTOUR. These binary files are processed by CONVERT.EXE, producing the NMPLOT.GRD file. This file is processed by NMPLOTX.EXE, producing the CONTOURS.DAT file. This file contains noise contour data that are read and displayed in INM. Do not rename or delete this subdirectory.

3) **NMPLOT** — This system subdirectory contains software relating to the NMPLOT program, which is a part of the U.S. Air Force NOISEMAP airport noise model. INM uses a special version of NMPLOTX.EXE (Version 3.04), which can be run in batch mode. NMPLOT can also be used as an interactive program to directly manipulate GRD files. NMPLOT has on-line help information but no documentation. Do not rename or delete this subdirectory.

4) **SYS_DATA** — This system subdirectory contains the INM standard database binary file and DBF files. INM standard data are maintained in the ACDB51.BIN file. This file contains 11 DBF files in an encrypted compressed binary format. If you see a message when INM loads about a "archive" error, it means that there is a problem with the ACDB51.BIN file. Standard data are secure because INM reads the binary file, not the

DBF files. The DBF files are included for your information. Do not rename or delete this subdirectory. Do not delete the ACDB51.BIN file.

5) **SYS_DBF —** This system subdirectory contains templates for all of the DBF files that are used by INM. A template is a DBF file without any records. Do not rename or delete this subdirectory or any of the files it contains.

6) **USR_DATA —** This system subdirectory contains DBF files that are used by INM, but you can adapt them for your own use (for example, you can add airport data). Remember to save your modified USR_DATA files if you load a new version of INM. Do not rename or delete this subdirectory.

7) **PROCESS —** This system subdirectory contains software that supports source data processing, including files and programs needed by PREPROC.EXE. There are seven subdirectories under PROCESS:

- The **CENSUS** subdirectory contains software that PREPROC uses to process U.S. Census CD-ROM data and produces street map and population graphics files for display.

- The **CONV411** subdirectory contains software that converts an INM 4.11 input text file into INM 5.1 DBF files.

- The **DXFCAD** subdirectory contains software that processes a DXF file and produces a graphics airport-drawing file for display.

- The **OAGDBF** subdirectory contains an example text file of OAG input data that can be processed by PREPROC to produce flight operations DBF files.

- The **RADARTRK** subdirectory contains an example text file of input radar track data that can be processed by the INM Files // Import function to produce graphics radar-track files for display.

- The **TERRAIN** subdirectory contains software that processes CD-ROM data and produces a binary file of terrain elevation data used by the noise computation module. The software also produces a binary graphics terrain-contours file for display.

- The **TXTDBF** subdirectory contains an example text file of input track and flight operation data that can be processed by the INM Files // Import function to produce DBF files.

8) **EXAMPLES** — This subdirectory contains two example Studies. The TEST411 Study contains data converted from the INM 4.11 TESTCASE.INP file. The TEST50 Study demonstrates new features in INM 5. The EXAMPLES subdirectory takes up a large amount of disk space. You can move or delete this subdirectory, if you wish. Do not put your own Studies under the EXAMPLES system subdirectory because when you install another version of INM, you may forget and delete the old INM directory, possibly destroying your Studies.

9) **Study** directory — You create a Study directory when you start a new study using INM. An INM Study consists of study-level files (for example, Runway Ends), additions and changes to INM standard data, Case subdirectories of files, and Output subdirectories of files. A Study directory <u>can be</u> renamed, copied, and/or moved to a different place on your disk or network. Use the 8-dot-3 DOS naming convention.

10) **Case** subdirectories — A Study consists of one or more "Cases" (for example, a base case and two alternatives). Both Study and Case data are used as input data for the noise calculation module. Tabular output data from a run are written into the Case subdirectory. You create the Case subdirectory inside of INM, and INM manages it. INM does not allow you to change the name of a Case subdirectory once it is created. Do not delete a Case subdirectory outside of INM; use INM instead.

11) **Output** subdirectories — Noise contour data and output graphics data are placed in "Output" subdirectories. The reason for having Output subdirectories separate from Case subdirectories is so that you can combine Case output data for different kinds of output. For example, you can create Output noise contours showing the <u>difference</u> between two Cases. You create the Output subdirectory inside of INM, and INM manages it. INM does not allow you to change the name of an Output subdirectory once it is created. Do not delete an Output subdirectory outside of INM; use INM instead.