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U.S. Department of Transportation
Federal Highway Administration

FREQUENTLY ASKED QUESTIONS

TRAFFIC NOISE MODEL 3.0

FHWA-HEP-20-009
FEDERAL HIGHWAY ADMINISTRATION
OFFICE OF NATURAL ENVIRONMENT
Washington, D.C.

Getting Started

Please also note that TNM 3.0 has a **USER MANUAL** and **GETTING STARTED GUIDE** embedded within the software, which may answer some of your questions. In addition, the FHWA provides short **HOW-TO VIDEOS** that demonstrate how to accomplish basic tasks in TNM 3.0.

General Information

HOW MANY VERSIONS OF TNM 3.0 ARE THERE?

There is one model with the basic structure of an acoustics library, a GUI that allows user input, and a data structure that stores the GUI inputs and acoustic outputs.

There are two (2) versions of this TNM 3.0 available for download. They differ in what software underlies certain Graphical User Interface (GUI) views, and whether there is an ongoing fee to the end user or not.

Both versions use the same acoustical library and algorithms; provide equivalent results; and use the same underlying software for the GUIs 3D View, Section (or Cut) View, Report view Legend, Edit, and Object Details pane. As such, they are considered to be one model with different GUI tools implemented for the end user.

WHAT ARE THE DIFFERENCES BETWEEN THE TWO VERSIONS OF TNM 3.0?

The main differences are costs to the end user, and the aesthetics in the GUIs various views for the project. Both versions will provide the same acoustical results.

One version relies on ESRI's proprietary software to render the Basemap and Plan View; as well as to implement Bookmarks, Annotations, and Geocoding. This version of TNM 3.0 requires the end user to provide their own ArcGIS Runtime License. This can be obtained from ESRI for a fee. Users should check with their organization to verify whether they have such a license already available – many did for the 2017 Draft Release of TNM 3.0.

The other version of TNM 3.0 has no costs to the end user. The Department of Transportation already paid the upfront costs for the software that renders the Basemap and Plan View in this version. Bookmarks and Annotations are not currently supported in this version, but may be added during a later development cycle. This version also allows the user to switch from aerial views to other map views, such as terrain, without needing to close and reopen the software.

WHAT ARE TNM 3.0'S SYSTEM REQUIREMENTS?

The following are the minimum specifications for deploying either version of TNM 3.0 for users to consider prior to attempting to install the TNM applications. Please note that disregarding these minimum specifications and deploying TNM 3.0 on a computer below these specifications will result in either inoperable software or less than optimal software performance.

OPERATING SYSTEM:

64-Bit

Windows 7 or higher (not compatible with Mac OS, Unix or Linux)

CPU:

Intel® Core i5 or i7 processor or equivalent

DISK SPACE:

2.0 GB or more of available hard drive space for installation

20 GB or more of available hard drive space for working

RAM:

16.0 GB

GRAPHICS CARD:

Intel® HD Graphics or equivalent

HOW MUCH DOES TNM 3.0 COST?

TNM is provided to the public at no cost. However, the use of the ESRI Plan View Tools requires the purchase of an ESRI Runtime license.

WHERE CAN I OBTAIN TNM 3.0?

TNM 3.0 can be obtained from the Federal Highway Administration’s (FHWA) Noise program webpage (<https://www.fhwa.dot.gov/environment/noise/>).

DO I HAVE TO USE TNM 3.0?

No, TNM 3.0 is available for voluntary use until FHWA updates the noise rule at 23 CFR 772.

WHAT IS THE MOST RECENT VERSION OF TNM?

The most recent version of TNM is TNM 3.0.7.6002.

HOW CAN I DETERMINE WHICH VERSION OF TNM 3.0 I AM RUNNING?

The exact version of TNM 3.0 that is running can be determined by clicking the **ABOUT** icon under the **HELP** tab.

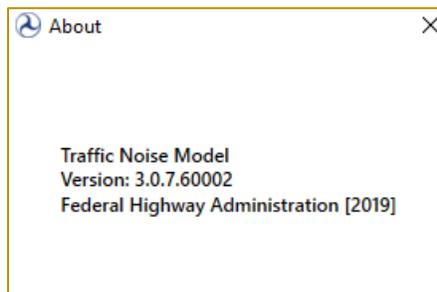


Figure 1 TNM Version Number Dialog Box

CAN I USE TNM 2.5 RUNS IN TNM 3.0?

TNM 2.5 runs cannot be used directly in TNM 3.0; however, the TNM 2.5 to TNM 3.0 Exporter (TNM Exporter) can be used to load a TNM 2.5 run and then export it to a 3.0 compatible format.

WHERE DO I DOWNLOAD THE TNM 2.5 TO TNM 3.0 EXPORTER (TNM EXPORTER)?

The TNM 2.5 to TNM 3.0 Exporter is available for download from the FHWA's Noise program webpage (<https://www.fhwa.dot.gov/environment/noise/>). Instructions for installation and use are included in the readme file.

CAN I RUN MULTIPLE VERSIONS OF TNM ON MY COMPUTER?

Both TNM 2.5 and 3.0 can be run on the same computer at the same time.

CAN I RUN MULTIPLE INSTANCES OF TNM 3.0 ON MY COMPUTER?

Multiple instances of TNM 3.0 cannot be run on the same computer at the same time.

CAN I COMPUTE MULTIPLE RUNS AT THE SAME TIME ON MY COMPUTER?

To compute multiple runs at the same time on the same computer, use the Batch Tool.

WHERE CAN I OBTAIN A COPY OF THE TNM DOCUMENTS?

Copies of all documents associated with TNM 3.0 can be found on the FHWA's Noise program webpage (<https://www.fhwa.dot.gov/environment/noise/>). Available documents are:

- Technical Manual
- Validation Report
- User's Guide (also available inside TNM 3.0 as the Help Menu)
- Getting Started
- Fact Sheet
- Consistency Test Suite

WHERE CAN I OBTAIN TECHNICAL SUPPORT?

The FHWA and the Volpe Center can provide more information and technical support through TNMHelp@dot.gov.

HOW DO I GET THE LOG FILE?

Go to *MyDocuments\TNM\Logs*. For the current log file, search for the file with the extension .log; for past logs go to *MyDocuments\TNM\Logs\Archives* and search for the file with the .log extension for the applicable date.

Acoustics

WHAT MODIFICATIONS AND BUG FIXES HAVE BEEN IMPLEMENTED IN TNM 3.0?

Updated algorithms have been implemented for the computation of the Fresnel ellipse, vehicle speeds and DNL (L_{DN}) computations.

New algorithms have been added for the computation of statistical levels (L_{10} and L_{50}).

Additional details can be found in the TNM 3.0 **TECHNICAL MANUAL**.

WHAT CHANGES IN METRICS HAVE BEEN MADE?

TNM 3.0 includes the ability to calculate the new metrics L_{10} and L_{50} , in addition to the existing metrics of L_{EQ} and L_{DN} found in TNM 2.5; however, the algorithms for computing L_{DN} have been updated.

Additional details can be found in the TNM 3.0 **TECHNICAL MANUAL**.

WHAT CHANGES HAVE BEEN MADE TO:

For more information on the following items, please also see the TNM 3.0 **TECHNICAL MANUAL**. The following items are listed in alphabetical order.

BARRIER REFLECTIONS?

Single barrier reflections are now calculated in TNM 3.0. These are implemented by creating an image source reflected about the barrier in question. Because the source is on the opposite side of the barrier, diffraction computations are evaluated for a barrier dropping down to the barrier height. That is, reflections only occur for the portion of the sound path that would normally be considered to be shielded from the receiver. This includes vertical reflections as well as diffractions. The direct and reflected sources are added incoherently because of the expected de-correlation that would result from passing through the turbulent region within the roadway corridor.

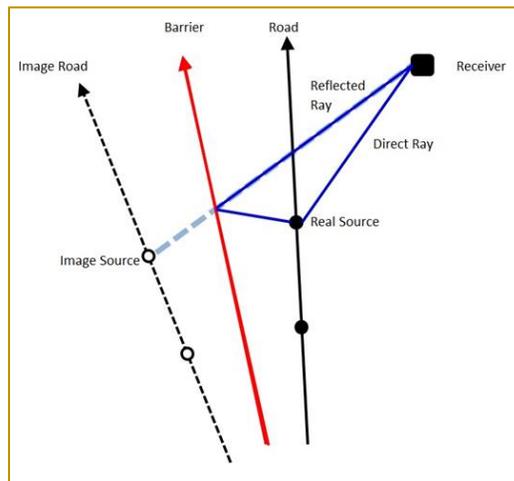


Figure 2 Single Barrier Reflections

CONTOURING?

The third-party software, NMPlot, has been removed from TNM in version 3.0. Contours are now generated directly in TNM. Further, contour lines have been replaced with color gradients to represent sound level as a function of location.

CONTROL DEVICES?

TNM 3.0 can accept the addition of control devices at any point of a roadway object.

Historically, control devices could only be applied to the beginning of a roadway. For example, in order to have a roadway with a stop sign, the road needed to be broken into two roadways such that the stop sign was at the beginning of the second roadway. This is no longer required.

EFFECTIVE FLOW RESISTIVITY?

Conversion values between NRC and EFR in the table below were updated to conform to the standard EFR values described in Table 2 / page 14 of the TNM 1.0 Technical Manual. Note that this functions as a look-up table. To use this, the user should select the NRC/EFR pair that best matches the barrier material.

EFFECTIVE FLOW RESISTIVITY (EFR) USED FOR VALUES OF NOISE REDUCTION COEFFICIENT (NRC)

NRC	EFR cgs Rayls	
	TNM 3.0	TNM 2.5
0.00	20000	20000
0.05	5000	4250
0.10	1570	1570
0.15	865	865
0.20	500	555
0.25	385	385
0.30	300	300
0.35	214	214
0.40	150	165
0.45	129	129
0.50	102	102
0.55	81	81
0.60	64	64
0.65	50	50
0.70	40	39
0.75	30	30
0.80	22	22
0.85	16	16
0.90	10	10.4
0.95	5.5	5.5
1.00	0.1	0.1

ELEMENTAL TRIANGLES?

TNM 2.5 guaranteed that subtended angles for all elemental triangles are 10° (ten degrees) or less. This was done in TNM 2.5 by creating contiguous 10° subtending angles until the remaining angle of the section is 10° or less. This means that often, the last triangle was much less than 10°. It could be, for example 9°, 1°, or even ½°.

Elemental triangles in TNM 3.0 are also guaranteed to be 10° or less, however, the angles are the same for an acoustically homogenous section. This is done by determining the minimum number of triangles with equal subtending angles less than or equal to 10°.

FREE-FIELD DIVERGENCE?

TNM 2.5 accounted for free field divergence only in the horizontal plane. It did not account for source or receiver heights. Thus, source/receiver distances that included a large vertical difference had their free-field divergence underrepresented. This is no longer the case in TNM 3.0.

TNM 3.0 acoustics account for both the horizontal as well as the vertical component of the free-field divergence.

NOISE EMISSIONS?

A few typographical errors were identified in the technical manual’s regression coefficients. These were not present in TNM 2.5’s code, nor are they present in TNM 3.0’s code. The differences between the code and the technical manual are highlighted in red below.

CONSTANTS FOR A-WEIGHTED SOUND-LEVEL EMISSIONS AND 1/3RD-OCTAVE-BAND SPECTRA

Vehicle Type	Pavement Type	Full Throttle	Coefficient	Technical Manual	TNM 3.0
HT	DGAC	NO	H2	-54.9684550	-54.9684450
HT	PCC	NO	G1	-298.5689955	-298.5689960
BUS	ALL	ALL	J2	-0.2825570	-0.2825557
MC	ALL	NO	C	56.0000000	56.0860990

ONE-THIRD OCTAVE BAND NOISE COMPUTATIONS?

TNM 2.5 interpolated below 250 Hz and extrapolated above 5000 Hz. These are a legacy of the effort to speed computations on the slower computers that were available at the time of TNM’s original development. This interpolation and extrapolation has been removed in TNM 3.0 in favor of explicit computation of these regions.

PAVEMENT TYPE HIERARCHY?

In the future, pavements may be permitted to have different acoustic impedances, so a Roadway Hierarchy was developed for TNM 3.0. The Hierarchy removes the ambiguity

of roadway acoustic impedance in situations where roadways overlap. The overlap precedence is as follows: mainline, ramp, shoulder.

ROADWAY SEGMENT WIDTH?

In TNM 2.5, roadway widths are assigned to roadways. This limits the ability to generate tapered roadway segments, which may occur when two roads merge. In TNM 3.0 Acoustics, roadway widths are assigned to each point on a roadway, so the road segments can have a uniform or tapered width. (Note, this feature can be seen graphically in the 3D View; however, the representation in the 3D View will only show differences in width based on roadway segment, not roadway point. The acoustics is based on these differences at the point level.)

VEHICLE SPEEDS?

The coefficients presented in Table 9 of Appendix B in the TNM 1.0 Technical Manual, repeated here for convenience, were modified to improve heavy truck deceleration computations. This was done, by using the same data as used in the original curve-fit, but then increasing the acceptable speed range. Therefore, it does not represent the results of new data, but rather represents the results of a new, more robust curve fit.

REGRESSION COEFFICIENTS FOR DECELERATING HEAVY TRUCKS (TNM 2.5)

Vehicle Type	A	B	C
Heavy Trucks	D exp (-E g), where D = 72.803 E = 0.180	F exp (-G g), where F = 3792.117 G = 0.105	1.303

REGRESSION COEFFICIENTS FOR DECELERATING HEAVY TRUCKS (TNM 3.0)

Vehicle Type	A	B	C
Heavy Trucks	D exp (-E g), where D = 64.606 E = 0.196	F exp (-G g), where F = 3996.848 G = 0.121	1.268

These coefficients are used in Equation 13 of Appendix B in the TNM 1.0 Technical Manual or Equation 34 of Appendix A in the TNM 3.0 Technical Manual:

$$s_x = 1.609 A + (121 - 1.609 A) \times \exp \left[- \left(\frac{\{0.3048 x + B [\ln(121 - 1.609 A)] - \ln(s_{entrance} - 1.609 A)\}^{1/c}}{B} \right)^c \right]$$

Graphical User Interface (GUI)

HOW DO YOU CREATE A MODEL?

Please see the TNM 3.0 **GETTING STARTED** document inside TNMs **HELP MENU** or separately at FHWA's Noise program webpage (<https://www.fhwa.dot.gov/environment/noise/>).

WHERE IS THE MODEL SAVED?

TNM 3.0 stores all TNM cases in a single database file stored in the Documents\TNM folder. The file is called tnm.dat. TNM creates this file the first time you run it and it starts out at around 5 MB in size, but can get very large when you save cases with results.

HOW DO I SHARE A MODEL WITH ANOTHER PERSON?

TNM 3 has **four** (4) export options.

You can export a case in the **TNM** format, which is a file with the same structure as the central TNM database file called tnm.dat. Exporting in this manner preserves all of the information from the case that is stored in the database. This file can be very large if you have calculated results.

You can also export to **.XML**, **GeoDatabase (.GDB)**, or **Computer Aided Design (.DWG)** formats.

However, the .GDB and .DWG functionality is currently experimental and not fully supported in the ESRI version of TNM 3.0; and not functional in the free version of TNM 3.0. The .GDB and .DWG formats preserve TNM 3.0 objects and their attributes, but do not preserve projection, results, barrier designs, or roadway/barrier pairings for roadways and barriers on structure. The file sizes tend to be much smaller than the TNM format files.

After exporting, you can transfer the file to the other person who can import the file into TNM on another computer.

WHAT IS A PROJECTION?

TNM 3.0 incorporates a variety of common projection options in both versions, including a Cartesian coordinate system that incorporates the flat plane found in earlier versions of TNM.

A projection is: A method by which the curved surface of the earth is portrayed on a flat surface. This generally requires a systematic mathematical transformation of the earth's graticule of lines of longitude and latitude onto a plane. Some projections can be visualized as a transparent globe with a light bulb at its center (though not all projections emanate from the globe's center) casting lines of latitude and longitude onto a sheet of paper. Generally, the paper is either flat and placed tangent to the globe (a planar or azimuthal projection) or formed into a cone or cylinder and placed over the globe (cylindrical and conical projections). Every map projection distorts distance, area, shape, direction, or some combination thereof¹.

¹ <https://support.esri.com/en/other-resources/gis-dictionary/search/>

WHICH PROJECTION SHOULD I USE?

The projection option you use depends on the project. It is important to always use the same projection for a specific TNM case. You only have to set the projection of a case when you create it, or if you import a **.XML**, **.GDB**, or **CAD** file. Files imported from TNM 2.5 are in **.XML** format and must be imported in the Cartesian projection in the same unit type (English or metric) used in the original TNM 2.5 case.

HOW DO I DIGITIZE A TNM OBJECT IN THE PLAN VIEW?

Please see the TNM 3.0 **GETTING STARTED** document inside TNMs **HELP MENU** or separately at FHWA's Noise program webpage (<https://www.fhwa.dot.gov/environment/noise/>).