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Federal Highway Administration

USER'S GUIDE

AUTOMATED CONSISTENCY TEST SUITE 1.0

FHWA-HEP-22-004
FEDERAL HIGHWAY ADMINISTRATION
OFFICE OF NATURAL ENVIRONMENT
Washington, D.C.

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13. ABSTRACT (Maximum 200 words)
The FHWA's Automated Consistency Test Suite Tool (ACTS Tool) is a Microsoft Windows® based software program that automates the process of comparing a suite of FHWA Traffic Noise Model (TNM) test runs in order to determine consistency between two implementations of TNM's acoustic algorithms. Given a suite of TNM test studies, the analyst uses two implementations of TNM's acoustic algorithms to create separate output results for each study for each implementation to be compared.

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1. INTRODUCTION

The FHWA's Automated Consistency Test Suite Tool (ACTS Tool) is a Microsoft Windows® based software program that automates the process of comparing a suite of FHWA Traffic Noise Model (TNM) test runs in order to determine consistency between two implementations of TNM's acoustic algorithms. This tool was developed to support the statement in 23 CFR 772.9 that allows for the use of an alternative noise analysis model, other than TNM in noise analysis for highway projects, if that model is determined by the FHWA to be consistent with the methodology in TNM.

Given a suite of TNM test studies, the analyst uses two implementations of TNM's acoustic algorithms to create separate output results for each study for each implementation to be compared. For example, consider the case where one wants to compare TNM 3.1 with the "ACME Noise Tool", which uses an implementation of TNM's acoustic algorithms and a notional test suite of ten TNM studies as follows:

- Test_Suite_Model_A.xml
- Test_Suite_Model_B.xml
- Test_Suite_Model_C.xml
- Test_Suite_Model_D.xml
- Test_Suite_Model_E.xml
- Test_Suite_Model_F.xml
- Test_Suite_Model_G.xml
- Test_Suite_Model_H.xml
- Test_Suite_Model_I.xml
- Test_Suite_Model_J.xml

In this example, the user would load each of the studies from the test suite above into TNM 3.1. The user would then use TNM 3.1 to calculate the results for all receivers in each study. After each study calculation, the user would save the study results in the same study file[1]. This process creates the first set of input files to be compared by the ACTS Tool.

The second set of input files is created by computing the results for the same studies by using the ACME Noise Tool. After each study calculation, the user would save the study results in a study file that includes all relevant TNM inputs and results. This process creates the second set of files to be compared by the ACTS Tool.

Once both sets of input files are created, the ACTS Tool can then be used to verify that the inputs are identical and that results for each receiver are consistent.

1.1 INSTALLATION

The installation of the ACTS Tool is accomplished via a setup file that can be downloaded from the FHWA website. Generally, administrator privileges are not required to install the software because it will install to the **C:\Users*UserName*\AppData\Local** folder, which is owned by the user. In some

*[1] TNM Study files follow the standard format described in "File Format Reference Manual – TNM 3.1", which can be found at TNM V3.1 - Traffic Noise Model - Noise - Environment - FHWA (dot.gov). Note, the FHWA's **Automated Consistency Test Suite Tool** uses tags described in this reference document and not the serialized results.*

instances, a user's IT policy may still restrict installation. In such cases, please consult your IT department for assistance in installing. To install the ACTS Tool:

1. Download the setup file located at the link below:
   https://www.fhwa.dot.gov/environment/noise/
2. Navigate to the download folder and find the Setup_ACTS_Tool.exe

***Figure 1**: ACTS Tool Setup File as it is shown in the Windows File Explorer*

3. Double click this file to start the installation process. The setup program will show the following dialog.

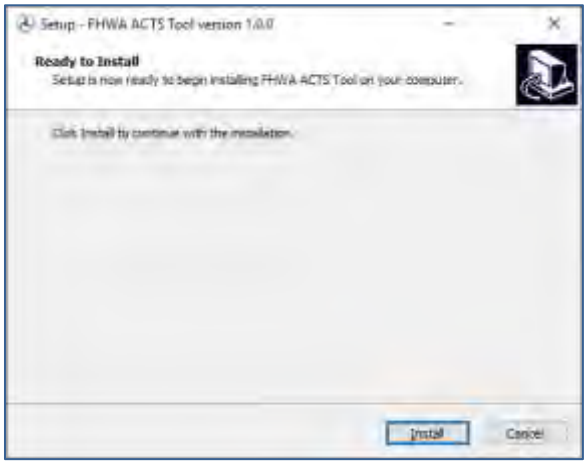


***Figure 2**: Starting Dialog for the ACTS Tool Setup Program*

4. Click on the install button in the dialog. The setup program will display a progress dialog.

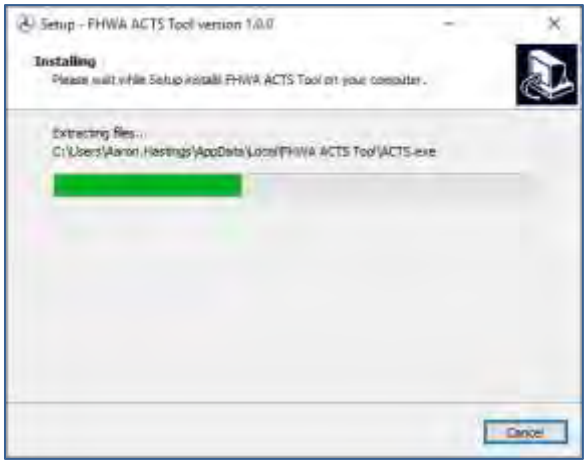


***Figure 3**: Progress Dialog for the ACTS Tool Setup Program*

5. When installation is complete, a final dialog will be shown giving the user an option to launch the launch the FHWA ACTS Tool. If this box is checked, the setup will launch the ACTS Tool after clicking the Finish button (see **Figure 6**). If the box is not checked, the setup will simply complete the installation after clicking the Finish button.

***Figure 4**: Completion Dialog for the ACTS Tool Setup Program*

Once the ACTS Tool has been installed, it can be launched by going to the Windows Startup menu by clicking the FHWA ACTS Tool icon under the FHWA ACTS Tool folder.

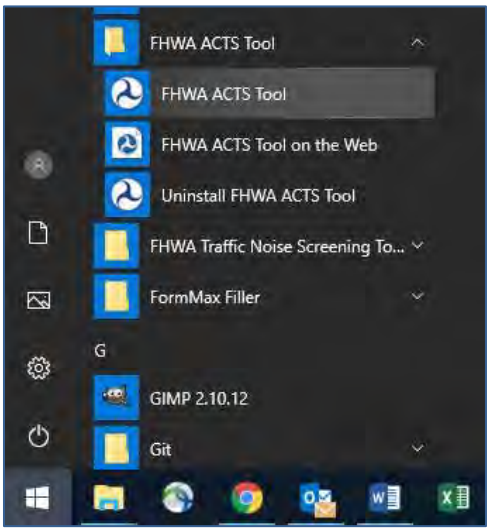


***Figure 5**: Launching the ACTS Tool from the Start Menu*

***Figure 6**: ACTS Tool at Startup*

1.2 STEPS TO USE THE ACTS TOOL

The sequence of steps to use the ACTS Tool are summarized as follows:

- Prior to Using the ACTS Tool
  - Compute receiver results and save to TNM Study XML study files using TNM
  - Compute receiver results and save to TNM Study XML study files using another software application
- In the ACTS Tool
  - Select an input method in the ACTS Tool
  - Select studies for the TNM Study Results in the ACTS Tool
  - Select studies for the Other Software Study Results in the ACTS Tool
  - Select an output location for the results
  - Start the analysis
  - Open the output folder once the analysis is complete
- After the ACTS Tool is finished
  - Any inconsistencies will be documented in the Excel spreadsheet generated by the ACTS Tool

2. Overview

This user's guide introduces the user to some of the basic concepts in using the Automated Consistency Test Suite Tool, including detailed steps to compare study results from two implementations of TNM's acoustic algorithms. The ACTS Tool is organized into areas that facilitate the workflow for completing a comparison of a set of studies. There are five areas as shown in **Figure 7**. The first area contains the Menu Bar. The second area allows for selecting an Input Method. The third area, "TNM Study Results for Comparison", allows for selecting the studies that have been computed using a reference version of TNM. (The reference version is the version of TNM that is to be compared against. The first available reference version is TNM 3.1. As new releases of TNM become available, the reference version will typically be the penultimate or latest release.) The fourth area, "Other Software Study Results for Comparison", allows for selecting the studies that have been computed using another software tool. This can be tool developed by someone other than FHWA, e.g. the notional "ACME Noise Tool", or it can be another version of TNM[2]. The fifth area allows the user to select a folder for outputting results, running the analysis, opening the results folder, and viewing messages.

***Figure 7**: ACTS Tool Overview*

[2] Only TNM version 3.1 and later versions of TNM will automatically create appropriate study files for import into the ACTS Tool. Previous versions of TNM do not automatically create appropriate study files. Software developed by someone other than FHWA will need to create files that are compatible with this format. (See footnote 1)

3. Menu Bar

The Tool Menu has a single option, which allows the user to exit the software. (Note that this functionality is identical to clicking on the "X" at the top right hand side of the tool.) The Help Menu has two options: About and User's Guide. The About option will open a dialog that indicates the current version of the tool being run, as shown in **Figure 8**. The User's Guide option will open this document.

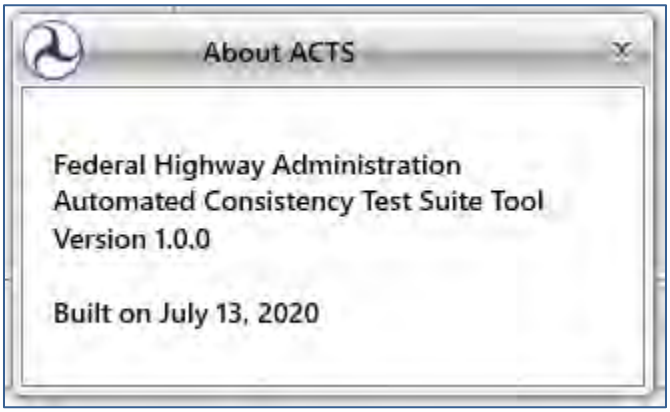


***Figure 8**: ACTS Tool "About" Dialog*

4. Input Method

The ACTS Tool has two input methods as shown in **Figure 9**: Batch Mode and File Mode. In order to switch between modes, the "TNM Study Results for Comparison" list and the "Other Software Study Results for Comparison" list must be empty, which is the default condition, and can also be achieved by pressing the Clear List button in each panel as discussed in Section 5.

***Figure 9**: Input Method*

4.1 Batch Mode

Batch Mode allows the user to select and compare a folder of output files from both TNM and other software.

The TNM study results must be in a separate folder from the other software study results. When the Batch Mode is used, for every file in "TNM Study Results for Comparison", there must be an identically named file in "Other Software Study Results for Comparison". Any extra files in "Other Software Study Results for Comparison" are ignored during the comparison.

4.2 File Mode

File Mode allows the user to select specific files to compare.

When comparing files, the file names do not have to be identical between "TNM Study Results for Comparison" and "Other Software Study Results for Comparison". However, the files will be compared in the order that they are listed. That is, the first studies in each list will be compared, then the second studies in each list will be compared, and so on until there are no additional studies in "TNM Study Results for Comparison". Any extra files in "Other Software Study Results for Comparison" are ignored during the comparison.

5. Study Results for Comparison

The Study Results for Comparison panels occupy the upper left hand ("TNM Study Results for Comparison") and right hand ("Other Software Study Results for Comparison") sides of the application. Interaction is described for the "TNM Study Results for Comparison" panel here, but the same process is applicable to the "Other Software Study Results for Comparison" panel as well. The options available for each depends on the mode selected in the Input Method panel.

5.1 Batch Mode

Initially in batch mode, the Study Results for Comparison panels will include the following:

- Title
- Software field
- Select Studies button
- Study List
- Clear List Button

These items are shown in **Figure 10**. Depending on the panel selected, the title will be either "TNM Study Results for Comparison", or "Other Software Study Results for Comparison".

The Software field allows the user to enter the version of the software that was used to generate the results in the list. The ACTS Tool will read the version from <savedBy> field in each TNM Study XML file and compare the version read with the version entered by the user. If two versions do not match then this will cause any comparison with this study to fail. ***Table 1*** provides examples of passing and failing comparisons for this field.

The ACTS Tool only compares the version value in the <savedBy> field up to the length of the user input software version. A shorter user input length results in a less precise comparison. This allows the user to determine how precise the comparison will be. If the user enters the full version value in Software field, the comparison will be most precise. If the user enters only a few characters/numbers in the string, the comparison will have some utility. If the user does not input any version value in the Software field, then the ACTS Tool will ignore this comparison and thus will not impact whether the study passes the consistency test.

Table 1: Potential Outcomes When Comparing User Input Software Versions

User Input Software Version	<savedBy> in TNM Study XML file	Consistency Result
TNM v3.1.12345	TNM v3.1.12345	Pass
TNM v3.1.1	TNM v3.1.12345	Pass
TNM v3	TNM v3.1.12345	Pass
TNM	TNM v3.1.12345	Pass
	TNM v3.1.12345	Pass
TNM v3.2	TNM v3.1.12345	Fail
TNM v3.12346	TNM v3.1.12345	Fail
TNM v3.123456	TNM v3.1.12345	Fail

In batch mode, clicking the Select Studies button will prompt the user to select a folder containing TNM Study XML files that have existing results computed. All valid TNM Study XML files in this folder will be added to the list for comparison. As discussed in Section 4.1, studies from two different software applications should be kept in separate folders.

 When a user selects a folder, the ACTS Tool will search this folder and all subfolders for valid TNM Study XML files. This feature can help the user to organize larger comparisons.

 When a new folder is selected, the current contents in the list will be overwritten.

The Study List has three columns labeled Name, Software, and Path. The Name is the file name associated with the study. The Software is the software version read from the <savedBy> field in the TNM Study XML files. (Note, if different software versions were used to calculate results for files in the same folder, this value will be different for some files.) The Path is the location of the folder where the files are located. (In Batch Mode this will be the same folder and subfolders.)

Once the user selects a folder, the Study List will be populated with all valid TNM Study XML files in this folder and its subfolders. Additionally, a "trash can" icon will appear to the right of the Study List, which indicates the Study delete function. See **Figure 11**.

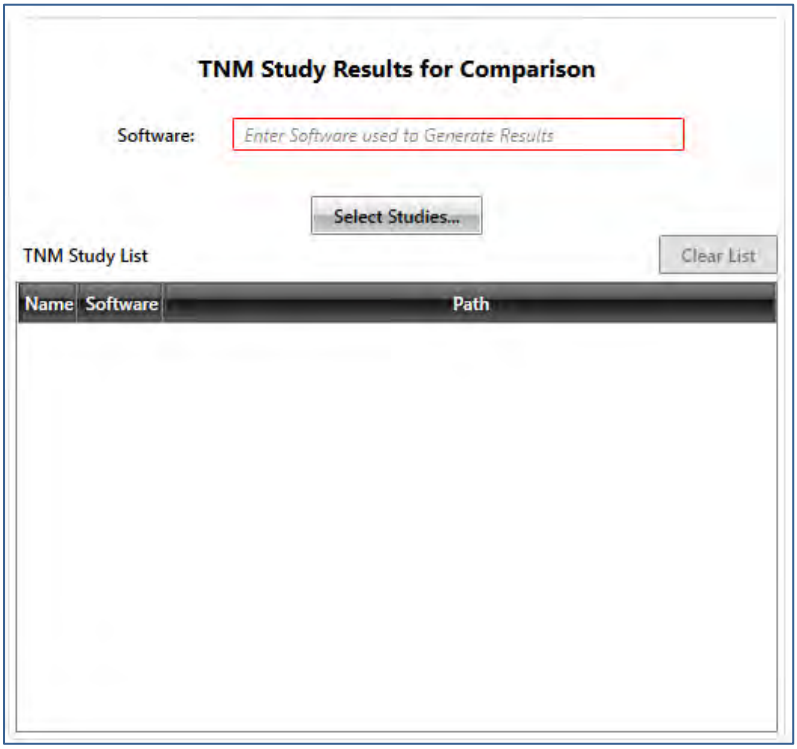


***Figure 10**: TNM Study Results for Comparison Panel in Batch Mode – Initial State*

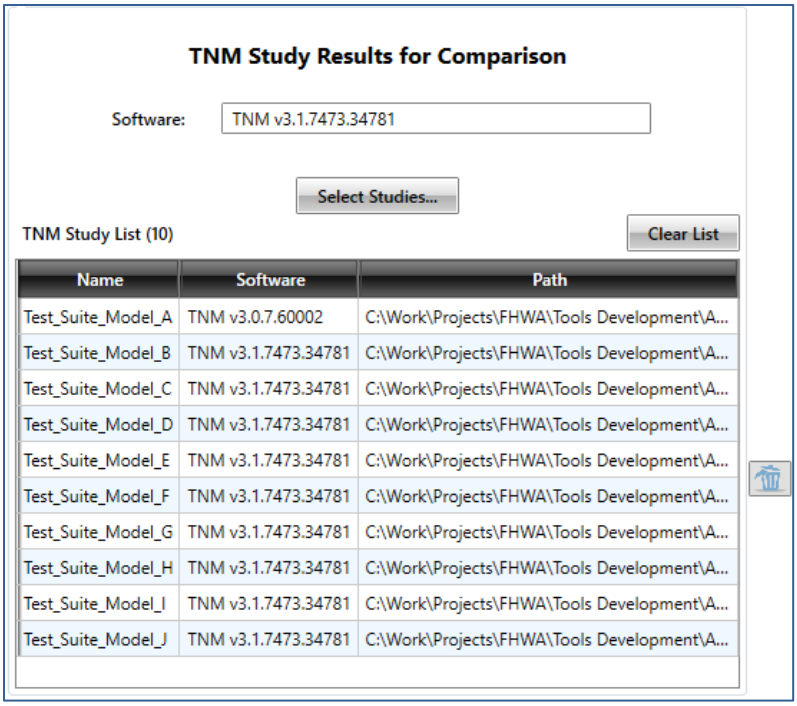


***Figure 11**: TNM Study Results for Comparison Panel in Batch Mode – Studies Populated*

There are two ways to edit the Study List in Batch Mode. A single study can be removed from the list by selecting the file in the Study List and then pressing the "trash can" icon to the right of the Study List. This can be repeated for multiple studies.

Remember, in batch mode, for every file in the "TNM Study Results for Comparison" Study List, there must be an identically named file in the "Other Software Study Results for Comparison" Study List. When using the Study delete function, be careful to not delete a file in the "Other Software Study Results for Comparison" Study List that will remain in the "TNM Study Results for Comparison" Study List. This will cause a consistency failure upon analysis.

The second method to edit the Study List in Batch Mode is to use the "Clear List" button to remove all studies from the Study List in the current panel.

5.2 File Mode

File Mode differs from Batch Mode in how the studies are compared and how the user selects files.

5.2.1 Study Comparisons

When File Mode is selected, comparisons are determined by the order in the Study List. The first file in the "TNM Study Results for Comparison" Study List is compared with the first file in the "Other Software Study Results for Comparison" Study List. This ordered comparison is continued until the last file in the "TNM Study Results for Comparison" Study List has been compared with a file in the "Other Software Study Results for Comparison" Study List. Any remaining files in the "Other Software Study Results for Comparison" Study List are ignored during the analysis.

Because comparisons are determined by file order in File Mode, file names do not need to match; however, there must be at least as many files in the "Other Software Study Results for Comparison" Study List as in the "TNM Study Results for Comparison" Study List for consistency to pass.

5.2.2 User Interface

With File Mode selected, rather than selecting studies based on a folder hierarchy, individual files can be selected from any number of unrelated folders. The files are added to the list in the order that they were selected. When studies are populated in the Study List, Up and Down arrows appear to the right of the panel (see **Figure 12**), which allow the user to modify the order of the files in the list.

Finally, an additional # column is added to the Study List. It is important to make sure that studies are aligned by their order in the list for File Mode in order to assure correct comparisons. The # column is intended to help the user with this task. When a study is found to be out of order compared to the other panel, the up and down arrow buttons can be used to change the order of the selected file.

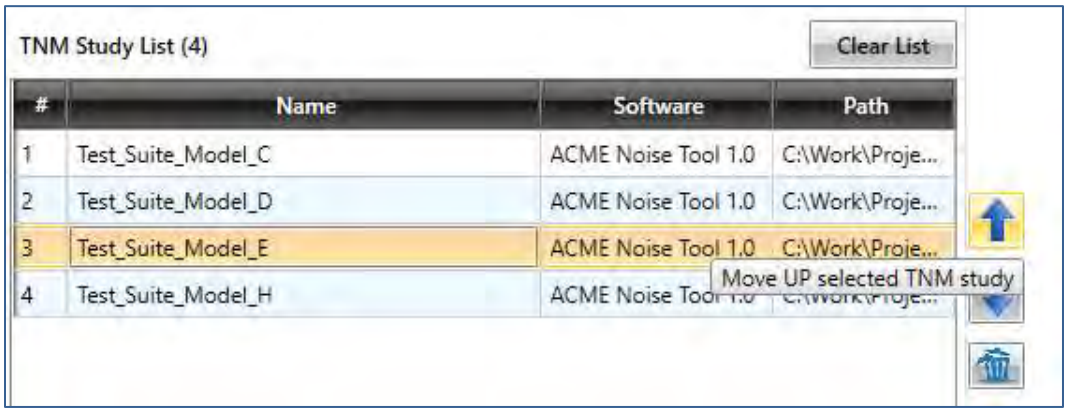


***Figure 12**: TNM Study Results for Comparison in File Mode – Reordering Files*

6. Output Location

The Output Location lets the user choose where to output the results from the ACTS Tool. Clicking the ellipses on the right side of this section opens a file explorer dialog, which prompts the user to select a directory. When the selected directory represents a valid path, a folder icon will appear to the left of the file path, as shown in **Figure 13**. When the directory represents an invalid path, a blank page icon will appear to the left of the file path, as shown in **Figure 14**. When the Output Location is an invalid path, the "Start Analysis" and "Open Output Folder…" buttons, directly below the Output Location, are disabled.

***Figure 13**: Output Location (Valid Path)*

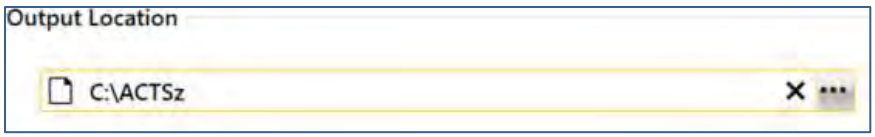


***Figure 14**: Output Location (Invalid Path)*

7. MESSAGES

While the consistency test is running, the Messages panel, located at the bottom of the application, will display updates for each study that is tested, as shown in **Figure 15**. The messages section will also keep a list of all consistency tests that are run while the application is open. Restarting the application will clear the Messages panel.

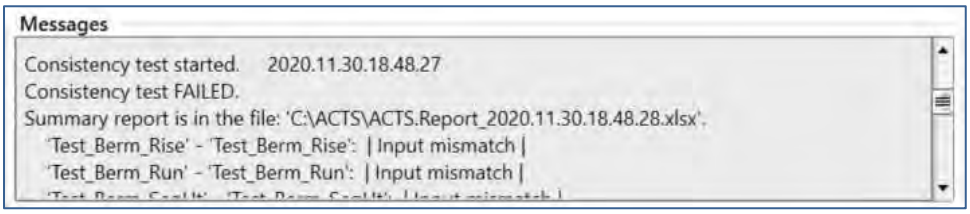


***Figure 15**: Messages*

8. ANALYSIS

Once the ACTS Tool has valid Study Lists for comparison and a valid Output Location has been selected, the user can click on the "Start Analysis" button to begin comparing the selected studies. This will prompt the ACTS Tool to display a small dialog window indicating progress in the analysis, as shown in **Figure 16**.

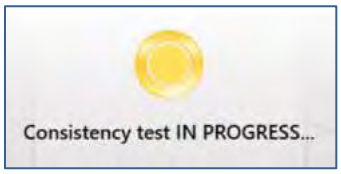


***Figure 16**: In Progress Window*

The circle between the "Start Analysis" and "Open Output Folder" buttons is grey and displays the text "Consistency test NOT STARTED" next to it by default. When the consistency test is running, it will be updated to reflect the current progress of the analysis using one of three indicators, as shown in **Figure 17**. While the analysis is underway, the yellow "Consistency test IN PROGRESS" indicator will be displayed. Once the analysis is complete, either the red "Consistency test FAILED" or the green "Consistency test PASSED" indicator will be displayed, depending on the results of the analysis.

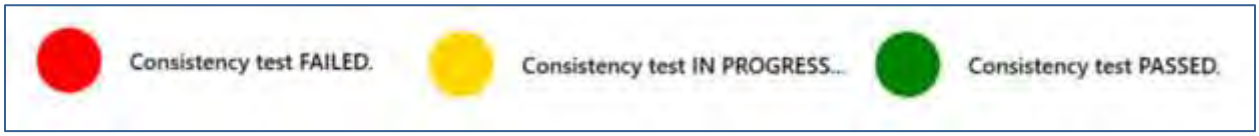


***Figure 17**: State of Consistency Test*

At this point, the user can review the detailed results by clicking on the "Open Output Folder" button.

9. RESULTS

Each time the ACTS Tool completes an analysis, it will save the results of the analysis in an Excel spreadsheet in the user specified output folder. The naming convention of this file is "ACTS.Report_YYYY.MM.DD.HH.MM.SS.xlsx", where Y, M, D, H, M, and S respectively represent year, month, day, hour, minute, and second.

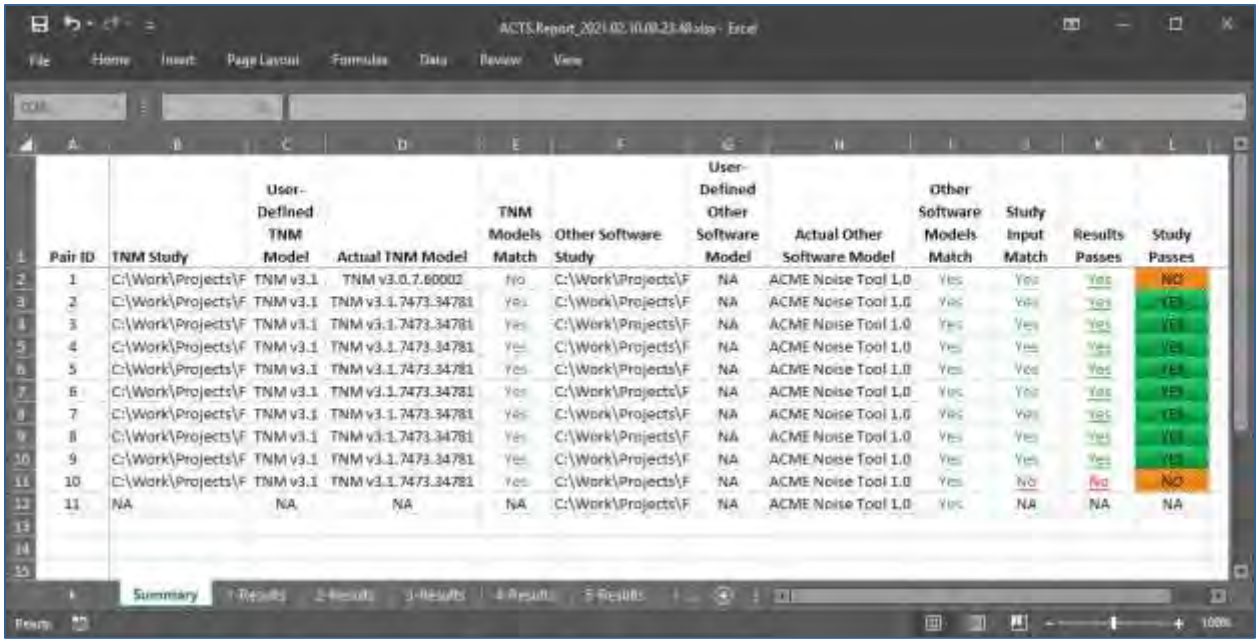
Although the user is free to delete results files, the ACTS Tool does not remove output files. In order to ensure that the latest analysis is being reviewed, the user should use the file with the latest date and time in the name.

The Excel file with the analysis results will contain a Summary tab and a #-Results tab for each file comparison. If there is an input mismatch for a given study comparison, there will also be an associated Input Mismatch tab in the output file.

9.1 SUMMARY TAB

Figure 18 provides an example of the summary tab for a case where ten studies in TNM were compared with ten studies in another application. In this case, there was an additional file in the other application that was not compared. A description of each column can be found in

TABLE 2. Aspects of a study that pass consistency tests are marked with a green Yes. Those that do not are marked with a red No. If a study as a whole passes the consistency test, it is marked by a Yes with a green background. If a study fails at least one aspect of the consistency test, it is marked by a No with an orange and red-striped background.



Pair ID	TNM Study	User-Defined TNM Model	Actual TNM Model	TNM Models Match	Other Software Study	User-Defined Other Software Model	Actual Other Software Model	Other Software Models Match	Study Input Match	Results Passes	Study Passes
1	C:\Work\Projects\F	TNM v3.1	TNM v3.0.7.60002	No	C:\Work\Projects\F	NA	ACME Noise Tool 1.0	Yes	Yes	Yes	NO
2	C:\Work\Projects\F	TNM v3.1	TNM v3.1.7473.34781	Yes	C:\Work\Projects\F	NA	ACME Noise Tool 1.0	Yes	Yes	Yes	YES
3	C:\Work\Projects\F	TNM v3.1	TNM v3.1.7473.34781	Yes	C:\Work\Projects\F	NA	ACME Noise Tool 1.0	Yes	Yes	Yes	YES
4	C:\Work\Projects\F	TNM v3.1	TNM v3.1.7473.34781	Yes	C:\Work\Projects\F	NA	ACME Noise Tool 1.0	Yes	Yes	Yes	YES
5	C:\Work\Projects\F	TNM v3.1	TNM v3.1.7473.34781	Yes	C:\Work\Projects\F	NA	ACME Noise Tool 1.0	Yes	Yes	Yes	YES
6	C:\Work\Projects\F	TNM v3.1	TNM v3.1.7473.34781	Yes	C:\Work\Projects\F	NA	ACME Noise Tool 1.0	Yes	Yes	Yes	YES
7	C:\Work\Projects\F	TNM v3.1	TNM v3.1.7473.34781	Yes	C:\Work\Projects\F	NA	ACME Noise Tool 1.0	Yes	Yes	Yes	YES
8	C:\Work\Projects\F	TNM v3.1	TNM v3.1.7473.34781	Yes	C:\Work\Projects\F	NA	ACME Noise Tool 1.0	Yes	Yes	Yes	YES
9	C:\Work\Projects\F	TNM v3.1	TNM v3.1.7473.34781	Yes	C:\Work\Projects\F	NA	ACME Noise Tool 1.0	Yes	Yes	Yes	YES
10	C:\Work\Projects\F	TNM v3.1	TNM v3.1.7473.34781	Yes	C:\Work\Projects\F	NA	ACME Noise Tool 1.0	Yes	No	No	NO
11	NA	NA	NA	NA	C:\Work\Projects\F	NA	ACME Noise Tool 1.0	Yes	NA	NA	NA

***Figure 18**: Example Summary Output*

TABLE 2: DESCRIPTION OF FIELDS IN THE SUMMARY TAB

Field Name	Description
Pair ID	Identifier for the study comparison.
TNM Study	File path of TNM Study.
User-Defined TNM Model	If a value was entered in the TNM Software field, it will be shown here, otherwise it is shown as NA.
Actual TNM Model	Version of TNM used to create the study. Read by the ACTS Tool from the TNM Study XML file.
TNM Models Match	A Boolean that states (Yes/No) whether the user defined and actual TNM models match. Comparisons are only made for the value length entered by the user. Will display NA if no comparison can be made.
Other Software Study	File path of Other Software Study.
User-Defined Other Software Model	If a value was entered in the Other Software field, it will be shown here, otherwise it is shown as NA.
Actual Other Software Model	Version of Other Software used to create the study. Read by the ACTS Tool from the TNM Study XML file generated by the other software.
Other Software Models Match	A Boolean that states (Yes/No) whether the user defined and actual Other Software models match. Will display NA if no comparison can be made.
Study Input Match	A Boolean that states (Yes/No) whether the inputs from both studies match. Will display NA if no comparison can be made.
Results Passes	A Boolean that states (Yes/No) whether the results from both studies match. Will display NA if no comparison can be made.
Study Passes	A Boolean that states (Yes/No) whether the TNM models, Other Software models, Study Input, and Results match between each study. If all studies pass this field, then the suite passes the consistency test. Will display NA if no comparison can be made.

9.2 RESULTS TAB

Each study comparison has its own Results tab in the output file that summarizes the results of the comparison of the study for the two implementations of the TNM acoustic algorithms. A sample Results tab output is shown in **Figure 19**. For each Results tab, there is a cell with "Back to Summary" in blue text in the top left corner. Clicking "Back to Summary" will open the summary tab. At the top of each Results tab is the path location of the TNM study that is being compared, the path location of the other software study that is being compared, and the tolerance that is used for receiver result comparisons. (This 0.5 dB tolerance is hard coded into the application.) Below these data, are nine columns (described in

TABLE 3), which contain a row for each receiver in the study.

Each receiver must have the same name in the TNM and other software files in order for the ACTS Tool to determine which receivers to compare.

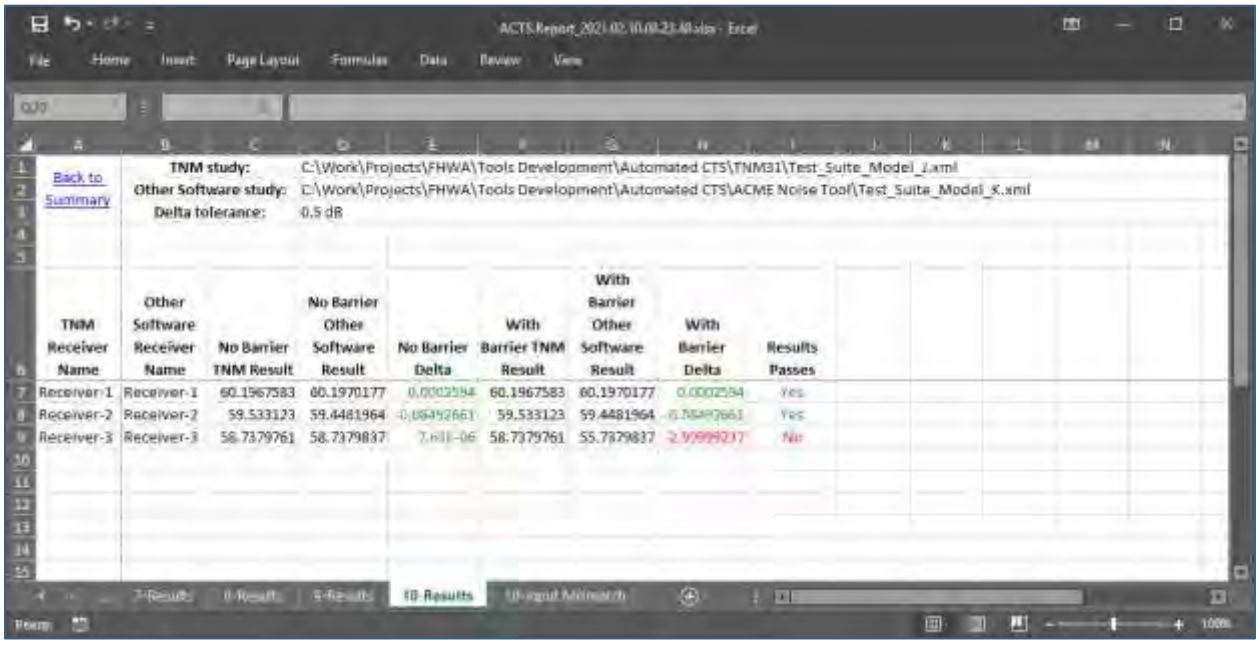


***Figure 19**: Example Results Output*

TABLE 3: DESCRIPTION OF FIELDS IN THE RESULTS TAB

Field Name	Description
TNM Receiver Name	Name of the receiver in the TNM Study XML file generated by TNM.
Other Software Receiver Name	Name of the receiver in the TNM Study XML file generated by the other software.
No Barrier TNM Result	Receiver results for the no barrier case in the TNM Study XML file generated by TNM.
No Barrier Other Software Result	Receiver results for the no barrier case in the TNM Study XML file generated by the other software.
No Barrier Delta	Difference between the two previous column entries. Text color indicates whether the delta is within the noted tolerance.
With Barrier TNM Result	Receiver results for the with barrier case in the TNM Study XML file generated by TNM.
With Barrier Other Software Result	Receiver results for the with barrier case in the TNM Study XML file generated by the other software.
With Barrier Delta	Difference between the two previous column entries. Text color indicates whether the delta is within the noted tolerance.
Result Passes	A Boolean that states (Yes/No) whether the receiver results match, within the noted tolerance, for both the No Barrier case and the With Barrier case. Text color indicates whether the delta is within the noted tolerance.

9.3 Input Mismatch Tab

When there is a mismatch in an element of a study between TNM and the other software, this is flagged as a reason for consistency failure and a separate Input Mismatch tab is created for this study. Items that can cause a mismatch include differences in any inputs that could affect the results, such as:

- Object geometry
- Ground zone EFR
- Traffic data
- Pavement type
- Barriers for abatement
- Receiver names

A sample Input Mismatch tab output is shown in **Figure 20**. For each Input Mismatch tab, there is a cell with "Back to Summary" in blue text in the top left corner. Clicking "Back to Summary" will open the summary tab. At the top of each Results tab is the path location of the TNM study that is being compared and the path location of the other software study that is being compared. Below these data, are three columns (described in ***Table 4***), which contain a row for each input mismatch for a given study.

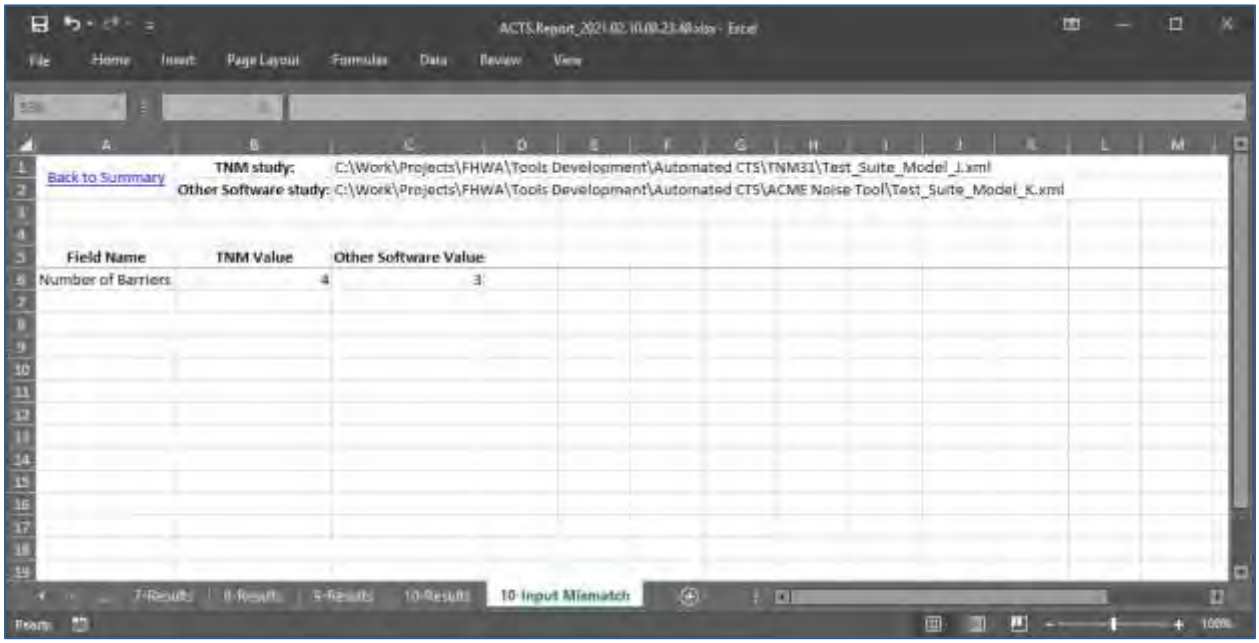


***Figure 20**: Example Input Mismatch Output*

Table 4: Description of Fields in the Input Mismatch Tab

Field Name	Description
Field Name	The name of the field containing the input mismatch
TNM Value	The TNM value for the given field
Other Software Value	The Other Software value for the given field