



Commercial Motor Vehicle Roadside Technology Corridor

Level-1/PBBT Analysis Tool

User Guide

Rev 1.1

Prepared by

Elizabeth Orlando, Mary Beth Lascurain, Zane H. Pannell
Oak Ridge National Laboratory



CONTENTS

	Page
CONTENTS.....	iii
LIST OF FIGURES	iv
1. BACKGROUND.....	1
2. QUICK START GUIDE	2
2.1 INTRODUCTION	2
2.2 ACCESSING THE TOOL.....	2
2.3 PRE-DEFINED ANALYSES AND REPORTS.....	4
2.3.1 Example 1: Level 1 vs. PBBT Correlation.	4
2.3.2 Example 2: Overall Efficiency.....	5
2.3.3 Example 3: Air Violations.	6
2.4 ANALYSIS TOOL.....	7
2.4.1 Example 4: Vehicles which failed both the Level 1 inspection and PBBT test.....	9
2.4.2 Example 5: SIRIS-flagged vehicles which failed both the Level 1 inspection and PBBT test.....	10
2.4.3 EXAMPLE 6: VEHICLES FAILING THE PBBT WITH DEFECT 393.45D.....	11
3. DETAILED USER INSTRUCTIONS	13
3.1 ANALYSIS TOOL OPTIONS	13
3.2 ADVANCED OPTIONS	14
3.3 ANALYSIS TOOL RESULTS.....	15
3.4 PRE-DEFINED ANALYSIS REPORT	15
3.4.1 Level 1/PBBT Correlation Report	15
3.4.2 Overall Brake Efficiency Report	15
3.4.3 Violations Report.....	16
3.4.4 Violation per Locations Report.....	16
3.4.5 Gross Vehicle Weight (GVW) Ranges Report	16
3.4.6 Wheel End Brake Efficiency Report.....	16
Appendix: INTERNET EXPLORER SETTINGS	17

LIST OF FIGURES

Figure 1. Login Screen.....	2
Figure 2. Interface Home Page	3
Figure 3. List of Available Pre-Defined Analyses.....	4
Figure 4. Level 1 vs. PBBT Correlation	5
Figure 5. Distribution of Brake Efficiency	6
Figure 6. Most Common Air Violations	7
Figure 7. Interface for User-Defined Analyses.....	8
Figure 8. Portion of Vehicles which Failed both PBBT and Level 1	9
Figure 9. Portion of SIRIS-Flagged Vehicles which Failed both PBBT and Level 1	11
Figure 10. Portion of Vehicles Failing the PBBT Test with Defect 393.45D	12
Figure 11. Interface Help Page	13
Figure 12. Advance Options Page	14

1. BACKGROUND

The North American Standard (NAS) Level 1 Inspection and Performance Based Brake Tester (PBBT) Correlation Analysis Tool was designed to help analyze and research the correlation between the Performance Based Brake Tester and traditional NAS Level 1 Inspections. It offers the ability to analyze the data separately or in correlation to one another.

This program was designed to further analyze data collected at the Federal Motor Carrier Safety Administration's (FMCSA) Commercial Motor Vehicle (CMV) Roadside Technology Corridor at a series of operational weigh and inspection stations along I-81 and I-40 in Tennessee by the researchers and interns at the National Transportation Research Center. Data collected is primarily Level 1 Inspection data and Performance Based Brake Tester data.

The Performance-Based Brake Tester is a device that measures brake forces at each wheel, axle, and for the vehicle as a whole in order to determine the current braking capability of a CMV. The measurement results are compared to the minimum brake performance standards that are specified in the Federal Motor Carrier Safety Regulations (Currently 43.5% brake efficiency is required for the overall vehicle).

The NAS Level 1 Inspection is an inspection that includes examination of the driver, vehicle (including brake systems, exhaust systems, fuel systems, etc.), and load requirements.

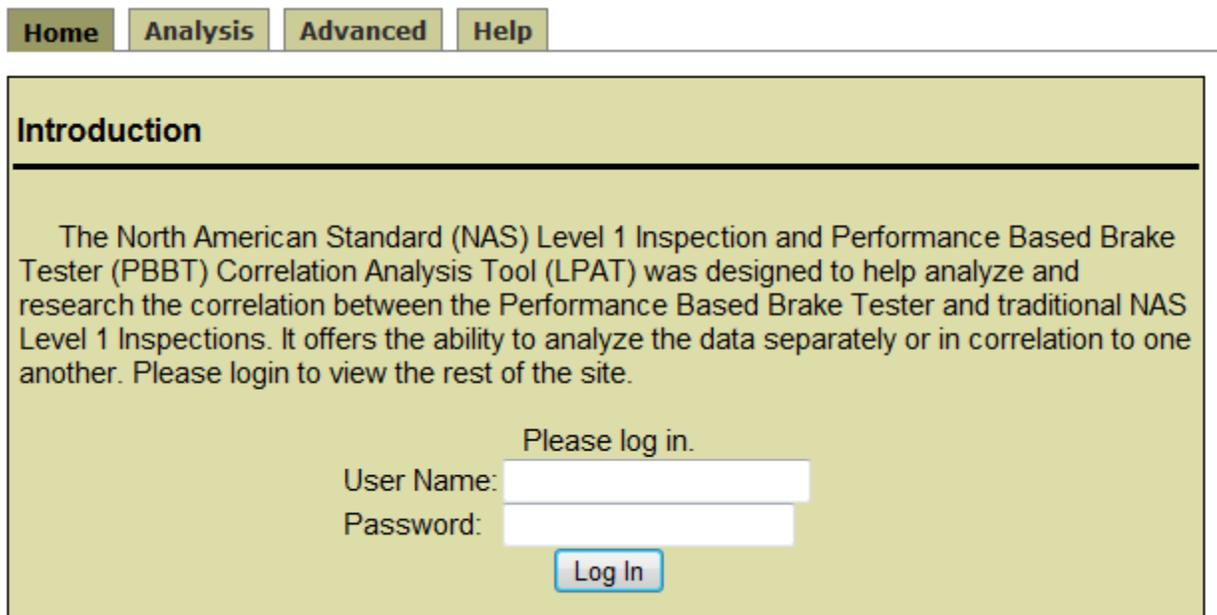
2. QUICK START GUIDE

2.1 INTRODUCTION

The Level-1/PBBT Analysis Tool (LPAT) was designed to assist in the analysis of North American Standard Level-1 Inspection and Performance-Based Brake Test results collected through various research efforts at the Federal Motor Carrier Safety Administration's Commercial Motor Vehicle Roadside Technology Corridor. This document outlines the basic functionality of this tool, providing explanations and examples of usage.

2.2 ACCESSING THE TOOL

Using appropriate credentials¹, log on to <http://ema.ornl.gov/lpat/> to access the tool as shown in Figure 1.



The screenshot shows a web browser window with a navigation bar at the top containing four buttons: 'Home', 'Analysis', 'Advanced', and 'Help'. Below the navigation bar is a large green box with the title 'Introduction'. Inside this box, there is a paragraph of text: 'The North American Standard (NAS) Level 1 Inspection and Performance Based Brake Tester (PBBT) Correlation Analysis Tool (LPAT) was designed to help analyze and research the correlation between the Performance Based Brake Tester and traditional NAS Level 1 Inspections. It offers the ability to analyze the data separately or in correlation to one another. Please login to view the rest of the site.' Below the text is a login form with the text 'Please log in.' above two input fields: 'User Name:' and 'Password:'. A 'Log In' button is positioned below the password field.

Figure 1. Login Screen

Internet Explorer users will need to enable the refreshing feature in their browser settings in order to view the analysis results; see Appendix for details.

After logging in, the "Home" page should look like Figure 2.

¹ For access to LPAT, contact Gary Capps, cappsgj@ornl.gov. New user accounts subject to FMCSA approval.

NAS Level 1 Inspection/PBBT Analysis Tool

[Home](#) [Analysis](#) [Advanced](#) [Help](#)

Introduction

The North American Standard (NAS) Level 1 Inspection and Performance Based Brake Tester (PBBT) Correlation Analysis Tool (LPAT) was designed to help analyze and research the correlation between the Performance Based Brake Tester and traditional NAS Level 1 Inspections. It offers the ability to analyze the data separately or in correlation to one another. Please login to view the rest of the site.

You are logged in.

For help using the site please select the "Help" tab above and click on the link to the user guide.



U.S. DEPARTMENT OF
ENERGY

August 2009 - [Disclaimer](#)

Figure 2. Interface Home Page

2.3 PRE-DEFINED ANALYSES AND REPORTS

Several pre-defined analyses are included to allow the user to easily determine general statistics of interest. These include the most common analyses such as the Level 1/PBBT correlation, most common violations, and PBBT statistics. To access the analysis options, select the “Analysis” tab.

Under the “Analysis” tab, select “Pre-Defined Analysis.” A complete list of all pre-defined analyses is available from the drop-down list shown in Figure 3.

NAS Level 1 Inspection/PBBT Analysis Tool : **Analysis** : Pre-Defined Analyses

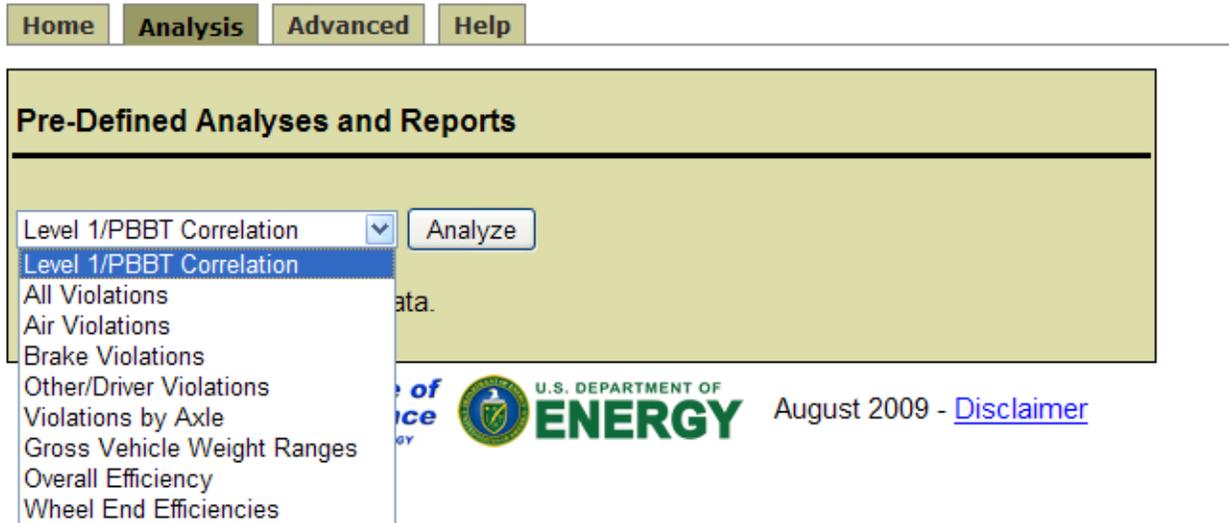


Figure 3. List of Available Pre-Defined Analyses

Several example pre-defined analyses and an explanation of the results are provided. To run a particular analysis, make a selection from the drop-down list and click Analyze. All pre-defined analyses are based on typical data—vehicles selected for inspection using normal enforcement protocols.

2.3.1 Example 1: Level 1 vs. PBBT Correlation.

All vehicles in the LPAT database have been given a Level 1 inspection and PBBT test; the correlation compares the results of these two metrics. Because the Level 1 and PBBT do not measure the same things, there may be differences in these results for each driver/vehicle combination tested may be different. Select this analysis as described above to determine these statistics; results will be similar to those shown in Figure 4.

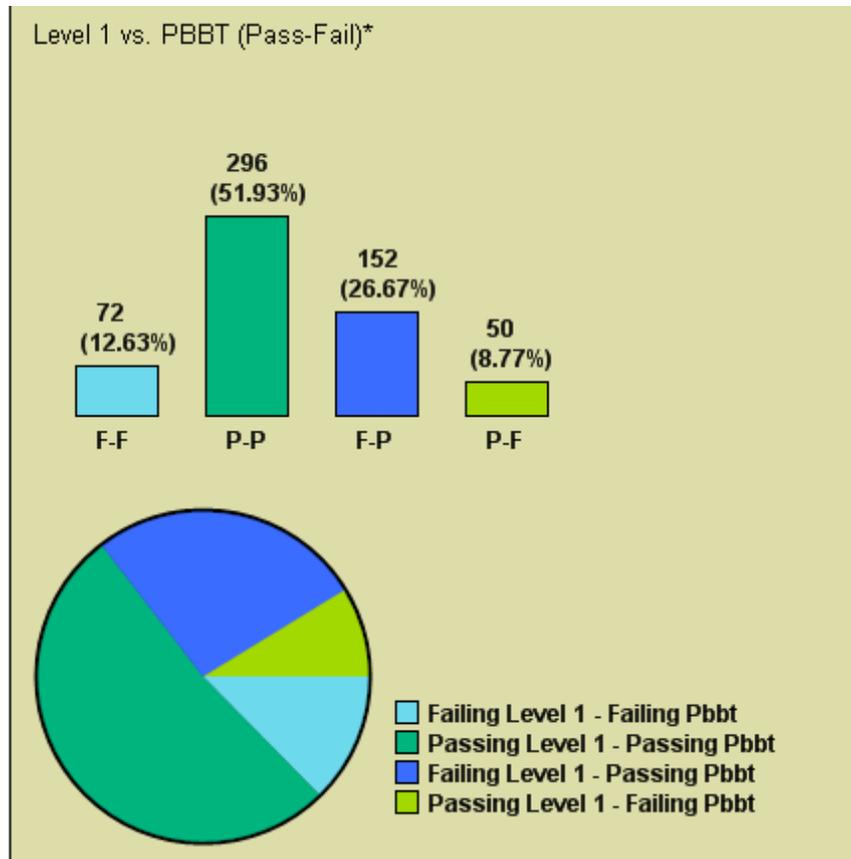


Figure 4. Level 1 vs. PBBT Correlation

This analysis was performed on a large sample of 570 vehicles, indicating the statistical viability of the results. The large green segment illustrates that slightly over half of all vehicles passed both the Level 1 and PBBT test. The Level 1 OOS rate for this set of data can also be determined from this data set by adding the two “Failing Level 1” rates (the two shades of blue, 12.63% and 26.67%), resulting in a Level 1 OOS rate of approximately 39%. A similar calculation for the PBBT results indicates that just over one fifth of all vehicles failed the PBBT test. These results also illustrate the concept that the PBBT provides additional information and about a vehicle and is not redundant with the Level 1 inspection. Nearly 9% of the vehicles were unable to generate sufficient braking force to pass the PBBT test, although they lacked the visible defects to place them OOS with a Level 1 inspection.

To return to the previous screen to select another analysis after viewing any results, click “Return to Pre-Defined Analysis and Reports.” Alternatively, the list may be reached by returning to the Analysis tab and choosing “Pre-Defined Analysis.”

2.3.2 Example 2: Overall Efficiency.

In order to pass the PBBT test the vehicle must score a 43.5% or higher brake efficiency (ratio of brake force to gross vehicle weight) as defined by §393.52 of the FMCSRs. While the previous example provides an overview of overall pass/fail rates, it does not provide information about how high the scores of the passing vehicles typically were or how poorly the failing vehicles performed on the PBBT. The “Overall Efficiency” pre-defined analysis provides this distribution of performance for the test vehicles. Selecting this option yields results similar to those shown in Figure 5.

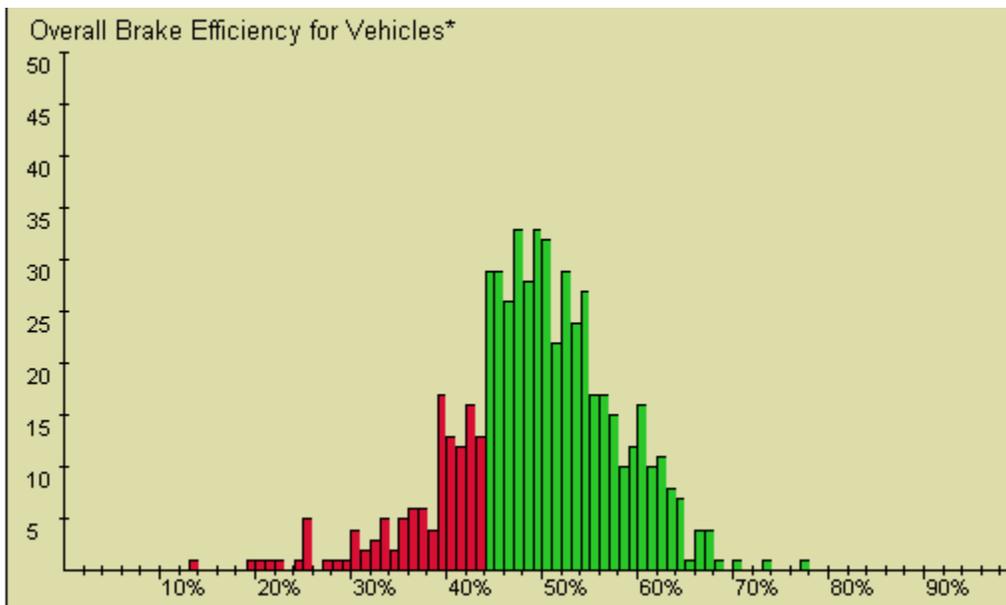


Figure 5. Distribution of Brake Efficiency

The results of this analysis show that of the 570 CMVs in the Typical category, with a PBBT almost one fourth of these CMVs fail to develop the minimum brake efficiency 43.5%, indicated by the area in red. These results are consistent with those in the previous example, where it was shown that slightly more than one fifth of the vehicles failed the PBBT. This histogram also indicates that over half of all vehicles had a brake efficiency between 43.5% and 54%; brake efficiencies higher than approximately 60% were rare. This PBBT distribution can also be used to predict the effect of changes in the performance criterion. For example, if the minimum brake efficiency were raised from 43.5% to 50%, approximately half of all vehicles would be expected to fail the PBBT test.

2.3.3 Example 3: Air Violations.

Several different systems are inspected as part of a Level 1 inspection; categories of inspection criteria used in LPAT currently include air-related, brake-related, and other (including driver-related). Related information of interest includes determining the most common types of violations; this information is available for air-related defects by selecting the pre-defined “Air Violations” analysis from the drop-down list. Air violations include a variety of defects such as insufficient air reserve and cracked brake hoses. Results are similar to those shown in Figure 6.

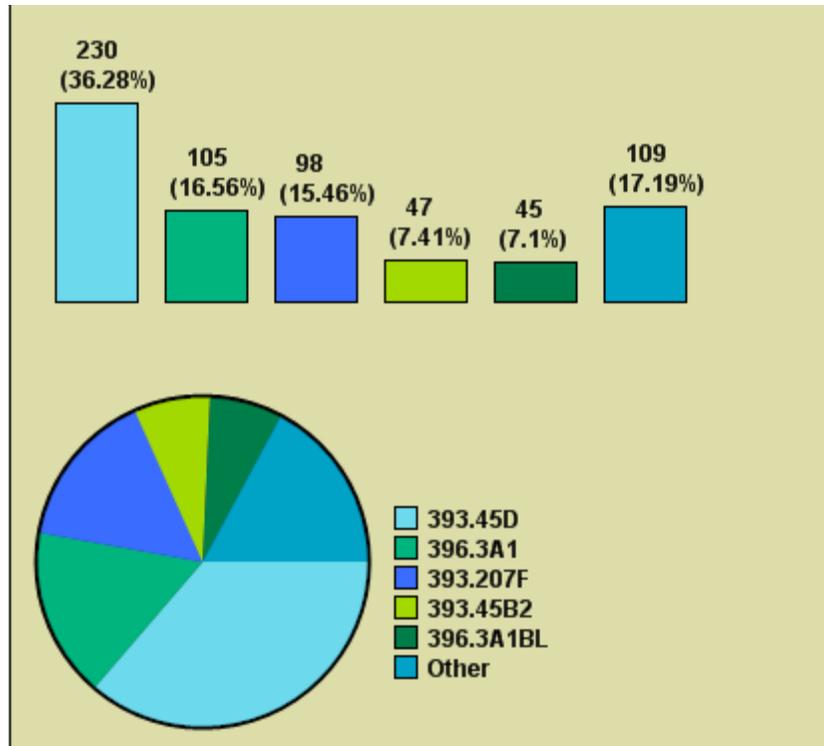


Figure 6. Most Common Air Violations

From this analysis, it is evident that that violation 393.45(d), which involves brake tubing and hose problems, is the most common air-related violation. This accounts for over one third of all air-related defects. Adding the percentages for the five most frequent air violations listed yields a total of 82.81%, indicating that the vast majority of air violations come from this set of five. These defects involve brake tubing and hose adequacy, air system repair and maintenance, air suspension pressure loss, brake hose or tubing chafing and/or kinking, and brake-reserve system pressure loss.

2.4 ANALYSIS TOOL

The Analysis Tool makes possible more focused analyses by allowing the user to select their own criteria to calculate statistics. The parameters include a variety of information related to a Level 1 inspection and PBBT test, as well as general fields such as type of vehicle. The analysis criteria can be set to be as broad or narrow as desired. To access this feature, under the “Analysis” tab click on “Analysis Tool.” The user interface is shown in Figure 7. After selecting the criteria for analysis, click the “Analyze” button at the bottom of the screen.

NAS Level 1 Inspection and PBBT Analysis Tool

Select Data Source:

Category: ▼

Select General Criteria:

Limit Analysis to a Specified Location:

▼ Right Left

No. of Axles: ▼ *

Date Range (MM-DD-YYYY): - *

Select Level 1 Inspection Criteria:

Pass or Fail: ▼ *

Violation Category:

Brake System Violation *

Air System Violation *

Driver Violation *

Specific Violation: *

▼

Select PBBT Criteria:

Pass or Fail: ▼ *

Brake Efficiency: ▼ % - % *

(GVW) Weight: ▼ lbs - lbs *

Model Year (YYYY): ▼ *

Figure 7. Interface for User-Defined Analyses

The analysis may be limited to the vehicles meeting certain criteria by checking the small boxes to the right of those criteria; otherwise, the analysis will be run for all data in the category selected. The default category is “Typical,” representing inspections performed on vehicles selected by enforcement personnel

using normal enforcement protocols. Other categories of data are intended for research purposes only and will not necessarily generalize to most enforcement situations.

2.4.1 Example 4: Vehicles which failed both the Level 1 inspection and PBBT test

The first pre-determined analysis example was a correlation study between the Level 1 inspection and PBBT test results; this analysis indicated that 12.63% of the vehicles failed both (Figure 4). This statistic can also be determined using the Analysis Tool using the following criteria:

1. In the “Category” box select “Typical – Typical data for Statistical Analysis.” This analysis will make use of the standard set of 570 vehicles selected using normal enforcement protocols.
2. Under the Level 1 Inspection Criteria section, select “Fail” from the drop-down list. From the typical vehicles, the analysis will be focused on vehicles that were placed OOS due the findings of the Level 1 inspection.
3. Under the PBBT Criteria section, select “Fail” from the drop-down list. This further focuses on the vehicles which failed the PBBT test.

Because the criteria are implemented using AND logic, the results indicate the percentage of vehicles which both failed the Level-1 inspection and failed the PBBT test. The results are shown in Figure 8.

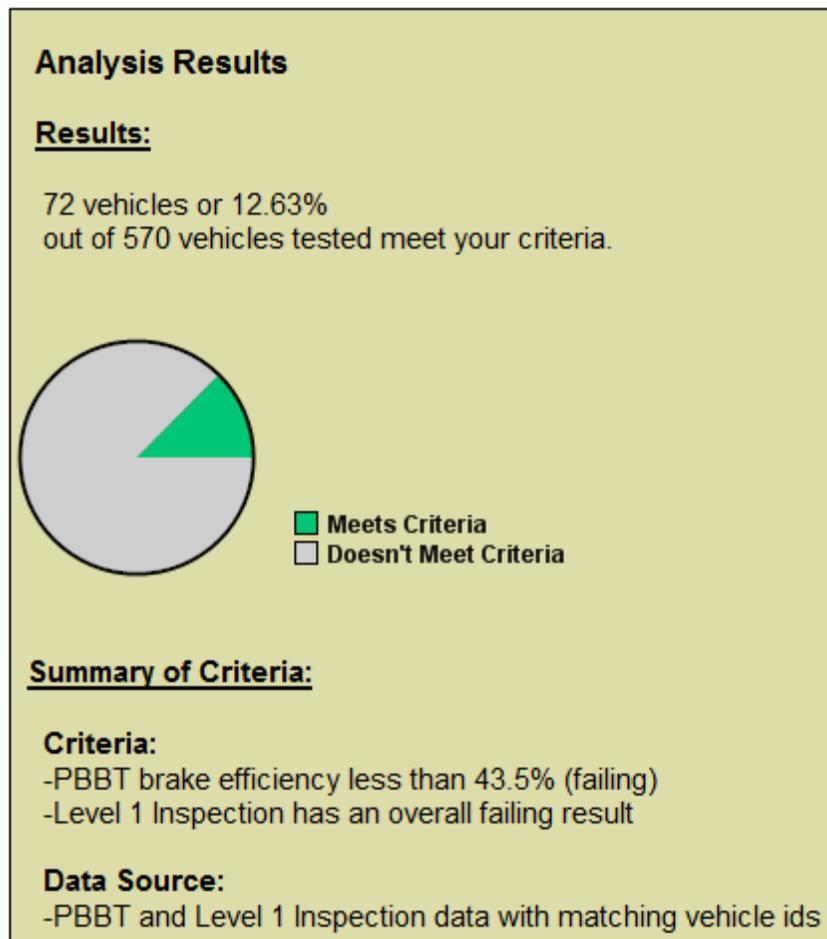


Figure 8. Portion of Vehicles which Failed both PBBT and Level 1

The Analysis Results indicate that 72 (12.63%) out of 570 CMVs meet the selected criteria. The green area of the pie chart graphically represents the portion of vehicles in the specified population (here, the “Typical” category of data) which met the selected criteria. As expected, the result is identical to that obtained using the pre-defined analysis feature.

2.4.2 Example 5: SIRIS-flagged vehicles which failed both the Level 1 inspection and PBBT test

Unlike the previous example, this analysis is based on data from vehicles which were flagged by the Smart Infrared Inspection System (SIRIS). Because SIRIS is a screening system designed to identify potential problems with brakes, bearings, and tires, the vehicles it flags for inspection are expected to have a high number of brake violations. To determine the proportion of these vehicles which failed both the Level-1 and PBBT, use the following analysis criteria:

1. Select “SIRIS-2 – Special Test Data” as the category This specifies the data from SIRIS-flagged vehicles for analysis; the “2” indicates the data collected with the second-generation system
2. Click OK on the pop-up box. This message warns that since the analysis is not being performed with typical data, the results should be interpreted accordingly.
3. Under the Level 1 Inspection Criteria section, select “Fail” from the drop-down list as in the previous example.
4. Under the PBBT Criteria section, select “Fail” from the drop-down list as before.

Click “Analyze” to obtain the results similar to those shown in Figure 9.

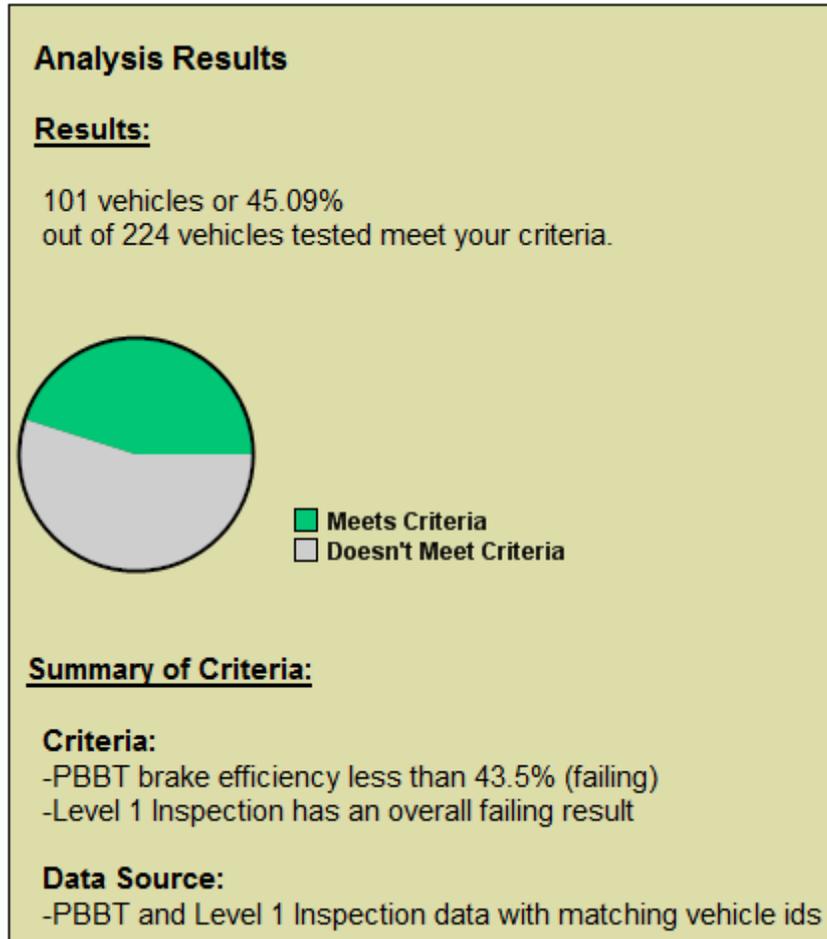


Figure 9. Portion of SIRIS-Flagged Vehicles which Failed both PBBT and Level 1

As shown, the analysis is based on a total of 224 vehicles—those that were flagged by SIRIS—rather than the 570 enforcement-selected vehicles of the previous example. As expected, the percentage of vehicles which meet the criteria (failing both the Level-1 and PBBT), is much higher—nearly half of all SIRIS-flagged vehicles. To further examine the effectiveness of SIRIS as a screening tool, this analysis could be repeated with the removal of the PBBT criteria. The result would show the total Level-1 OOS rate for SIRIS flagged vehicles to be even higher, providing the ability to predict the increase in OOS rates as a result of this screening tool.

2.4.3 Example 6: Vehicles failing the PBBT with defect 393.45D.

This analysis tool can also be used to determine the frequency of specific violations. In the third example (Figure 6), the most common air-related violation was found to be 393.45D, brake tubing and hose adequacy. Since this defect is expected to hamper a vehicle’s ability to develop sufficient braking force, it is expected that this violation will appear in some vehicles which failed the PBBT test. This example focuses on only on vehicles that failed the PBBT test in order to determine what portion of them violated FMCSA regulation 393.45D. To conduct this analysis, use the following settings:

1. Select the “Typical” Category

2. Under the PBBT Criteria section, select “Fail” from the drop-down list and check the box beside it. Placing a check mark in the box with an asterisk (*) limits the analysis to the sub-category of data which meets this criteria. In this example, the population of interest is which failed the PBBT test.
3. Under the Level 1 Inspection criteria, and select “393.45D” from the “Specific Violation” drop down menu.

Click “Analyze” to view the results as shown in Figure 10.

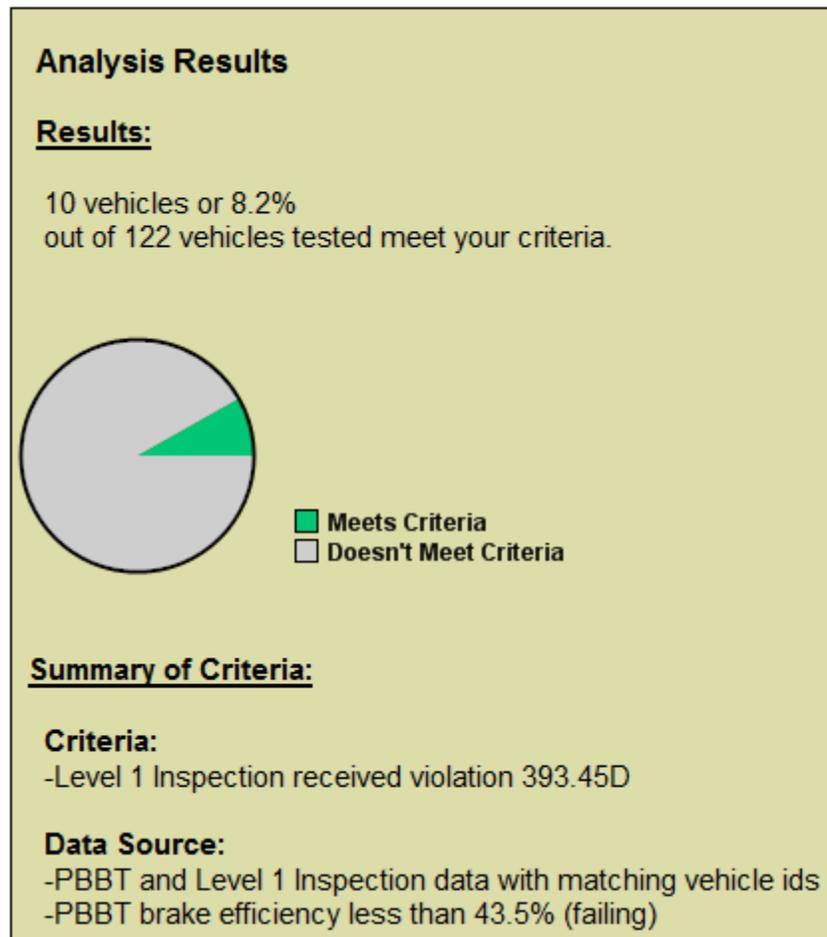


Figure 10. Portion of Vehicles Failing the PBBT Test with Defect 393.45D

Checking the asterisk box for the “Fail” PBBT criteria reduced the total number of vehicles used in the analysis from all 570 vehicles to the 122 which failed the PBBT test. These results indicate that nearly one tenth of all vehicles which failed the PBBT test had the most common air-related defect, 393.45D. Narrower criteria such as in this example allow the user to analyze smaller subsets of data.

3. DETAILED USER INSTRUCTIONS

3.1 ANALYSIS TOOL OPTIONS

By using the analysis tool options, you can understand how to input data to look up analysis and what it means. This section in the program is a helpful guide to make navigating through the software easier. To see the analysis tool options click on “User Guide” under the “Help” tab. This is shown in Figure 11.

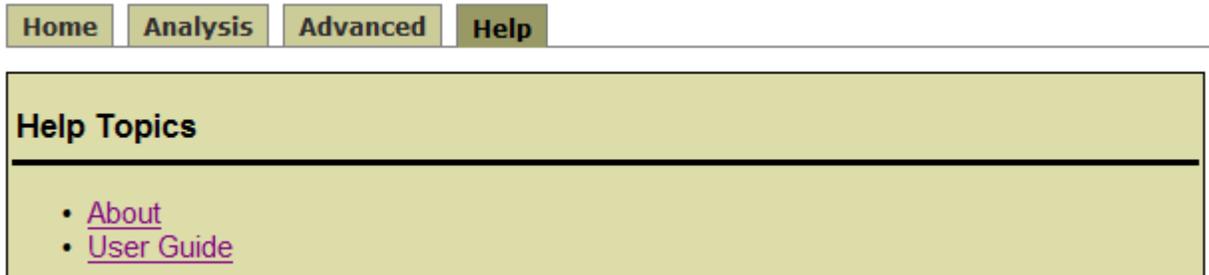


Figure 11. Interface Help Page

Data Source – In this section, the user can select whether to include NAS Level 1 Inspection data, Performance Based Brake Test data, or both in the data that will be analyzed. If both are chosen, they will be matched by their vehicle ids for a correlation.

Category – The categories are populated from the table of category choices in the database where the data resides. Only data tagged with the category chosen will be analyzed. Typical data is used for most circumstances and other categories are only for specific research analysis.

Location – The location of the axle or wheel end can be specified by selecting the axle number from the drop down and removing the check from the checkbox next to the side that is not desired. Location does not apply to age, inspection results (pass or fail) for NAS Level 1 Inspections, the date, or the category. All locations have the same age, date, and category. NAS Level 1 Inspections do not sufficiently quantify passing or failing per wheel end or axle.

No. of Axles – The number of axles available range from 1-11. Most data is from vehicles with 5 axles.

Date Range – The date recorded is the actual date of testing. Dates may be entered in any format that includes the numeric month, day, and year with separation such as slashes or dashes.

Pass or Fail – For a NAS Level 1 Inspection to be passing, none of the violations can put the vehicle out of service. If any violation results in the vehicle being put out of service, the NAS Level 1 Inspection is failed. For a PBBT test, brake efficiency greater than or equal to 43.5% are considered passing. Brake efficiency less than 43.5% is failing.

Violation Category – Violations have three categories: Brake System, Air Supply, and Other. Check the box in front of the desired violation category.

Specific Violation – Specific violations are listed according to their FMCSA regulation code. Categories for each violation are listed beside the regulation code. For additional information regarding the

individual violation codes, consult the [FMCSA website](#) for the current Federal Motor Carrier Safety Regulations.

Brake Efficiency – Brake efficiency is determined by the measured brake force of each axle divided by the measured weight of each axle. The overall brake efficiency for a vehicle is determined by the total brake force of all axles divided by the total weight of all axles. Choose a range of brake efficiency by entering the lower number in the first box and the higher number in the second box. Ex. 43-50. Choose specific brake efficiency by selecting an operator from the drop down next to the first box and enter the desired brake efficiency in the first box only.

Gross Vehicle Weight (GVW) – The weight of the vehicle is the GVW in pounds, measured at the time of the test. GVW is not available for NAS Level 1 Inspections. GVW must be given in numeric form without any letters or symbols. You may also select a range, equal to, greater than or less than. Ex. >=10000

Age – The age of the vehicle applies only to the tractor and is based on the model year. The age of the trailer is not available. When selecting an age, enter the year in which the tractor was made. Ex 2003.

3.2 ADVANCED OPTIONS

Advanced options allow you to look up specific violations in the software. If you know the vehicle id number you can view when the inspection took place and results of the inspection. Figure 12 shows the interface page for advanced options.

Home Analysis **Advanced** Help

Advanced Options

Choose options for your download:

Data:
PBBT ▼

Category:
Typical - Typical Data for Statistical Analysis ▼

Date Range (MM-DD-YYYY):
[] - []

Vehicle Id:
[]

Submit

Figure 12. Advance Options Page

Data – The user can select whether to download NAS Level 1 Inspection data or Performance Based Brake Test data. Both types of data can not be included in one file.

Category – The categories are populated from the table of category choices in the database where the data resides base on violations. Only data tagged with the category chosen will be in the download file.

Date Range – The date recorded is the actual date of testing. Dates may be entered in any format that includes the numeric month, day, and year with separation such as slashes or dashes.

Vehicle ID – The vehicle ID is matched to the vehicle ID in the database where the data is stored. If the vehicle is not found then a record of that data is not available. While this value typically matches the vehicle’s license plate, it may have been mistyped or have initials in front of them.

Once the criteria have been selected, the user will be redirected to a page with a download link. The file is named “Results.csv” and only available in comma separated values format with heading columns. The file is dynamically created each time from the current and available data based on your selected criteria.

3.3 ANALYSIS TOOL RESULTS

After selecting criteria and clicking the submit button, a results page is shown. If an error has occurred, the error will be listed below the results and the pie chart. The results include the number of vehicles matching the criteria entered, the percentage, and the total number of vehicles analyzed. A summary of the criteria chosen is listed below the results and pie chart. The pie chart shows the percentage of matching vehicles in green and the remaining percentage of vehicles analyzed in gray.

3.4 PRE-DEFINED ANALYSIS REPORT

Pre-Defined Analysis Reports are located under the “Analysis” tab. All reports are dynamically generated from data in the database when selected from the drop down.

3.4.1 Level 1/PBBT Correlation Report

The Level 1/PBBT Correlation Report can be selected from the Pre-Defined Analysis Reports, located under the “Analysis” tab. Data is matched using the vehicle id. The correlation is shown in shades of green and the miscorrelation is shown in shades of gray. F=fail; P=Pass. Ex. Fail – Pass this means the CMV failed the Level 1 inspection and passed the PBBT.

3.4.2 Overall Brake Efficiency Report

The Overall Brake Efficiency Report can be selected from the Pre-Defined Analysis Reports, located under the “Analysis” tab. The overall efficiency is determined by the total brake force of the vehicle divided by the total weight of the vehicle. These measurements are only recorded using the Performance Based Brake Test. The data is based on typical test data. The horizontal axis refers to the PBBT score; “>= 43.5” indicates a passing result and “<43.5” indicates a failing result. The vertical axis refers the number of instances.

3.4.3 Violations Report

The Violations Report can be selected from the Pre-Defined Analysis Reports, located under the “Analysis” tab. The violations shown are the ten most common violations found in all level 1 inspections. The code listed is the FMCSA regulation code. For additional information regarding the individual violation codes, consult the [FMCSA website](#) for the current Federal Motor Carrier Safety Regulations. The number listed about the bar is the number of CMVs based on the number of instances and percentage relative to the total number of instances.

- Air – Air violations are tagged as such in the database where the data resides. Only the five most common violations are shown.
- Brake – Brake violations are tagged as such in the database where the data resides. Only the five most common violations are shown.
- Other - Other violations are tagged as such in the database where the data resides. Only the five most common violations are shown.

3.4.4 Violation per Locations Report

The Violation Locations Report can be selected from the Pre-Defined Analysis Reports, located under the “Analysis” tab. This report shows the number of violations at each axle. Ex. “5LR” refers to the fifth axle, including both the left and right wheel ends.

3.4.5 Gross Vehicle Weight (GVW) Ranges Report

The GVW Ranges Report can be selected from the Pre-Defined Analysis Reports, located under the “Analysis” tab. The GVW are shown in ranges and represent the number of pounds measured for the overall vehicle.

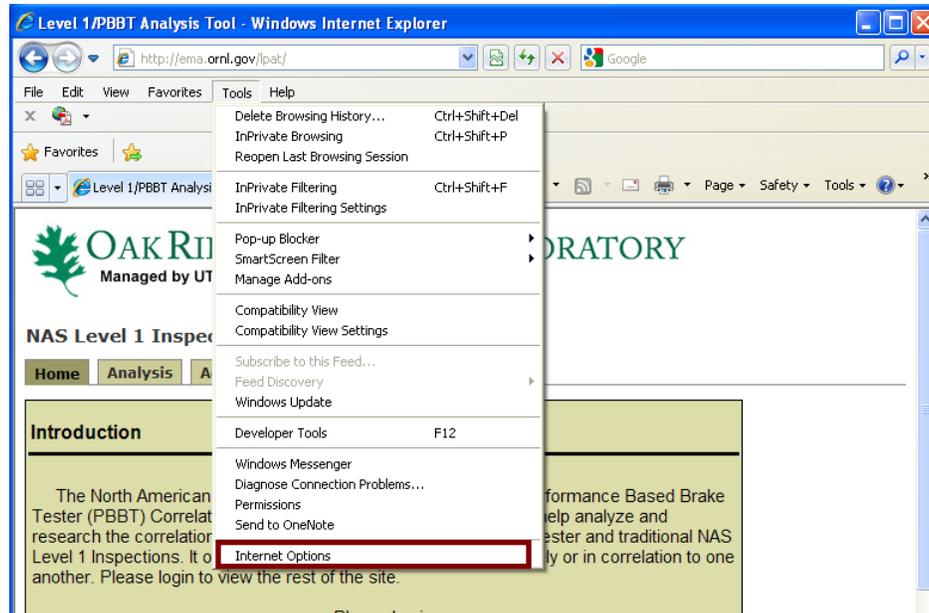
3.4.6 Wheel End Brake Efficiency Report

The Wheel End Brake Efficiency Report can be selected from the Pre-Defined Analysis Reports, located under the “Analysis” tab. The wheel end efficiency is determined by the brake force of the wheel end divided by the weight of the wheel end. These measurements are only recorded using the Performance Based Brake Test. The data is based on typical test data. The Horizontal axis refers to the PBBT score (≥ 43.5 means Pass and <43.5 means fail). The vertical axis refers the number of instances. Ex. From the drop down box 1R means first axle right wheel end. Pre-Defined Analysis Reports are located under the “Analysis” tab. All reports are dynamically generated from data in the database when selected from the drop down.

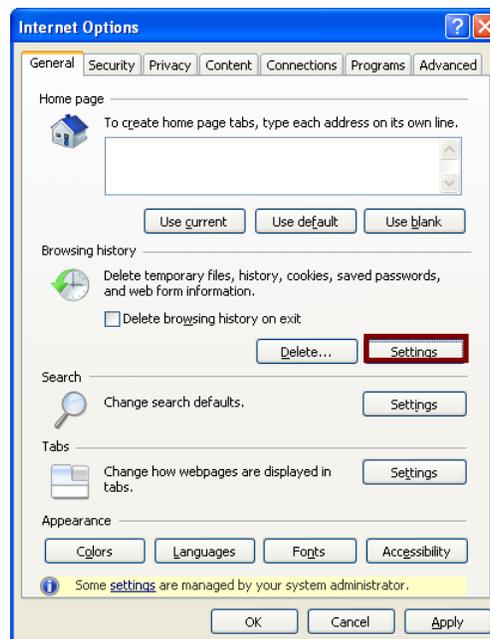
APPENDIX: INTERNET EXPLORER SETTINGS

The results pages used in LPAT are designed to automatically refresh with the latest data from each analysis. Internet Explorer users will need to enable this feature in their browser settings following the instructions below in order to view the analysis results. This additional step is not necessary for most other web browsers such as Mozilla Firefox and Google Chrome.

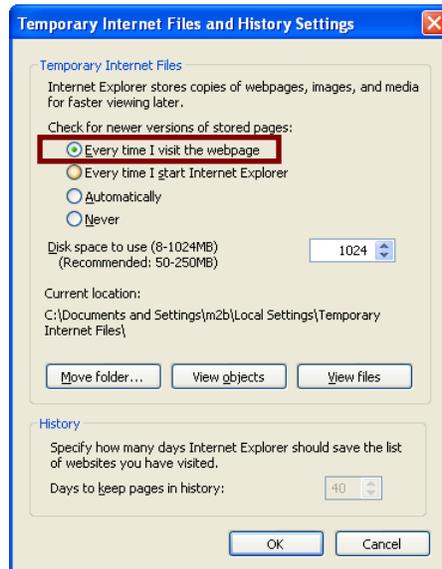
1. Go to **Tools > Internet Options**.



2. Under the **General** tab, in the **Browsing history** section, click **Settings**.



3. Select **Every time I visit the webpage** and click **OK**, **OK** to apply these settings.



This process will need to be performed for each workstation used to access LPAT.