



South Carolina  
Department of Transportation



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**Federal Highway  
Administration**

## SUMMARY REPORT

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# Development of Statistical Analysis Guidelines for Highway Materials and Research Activities

## BACKGROUND

SCDOT materials and research engineers deal daily with test data analysis, population comparisons, materials and procedural variability issues, and related statistical matters. Decisions affecting contractor payment, materials acceptance criteria, and specification development are part of their routine activities.

It is essential that these decisions be based on sound statistical principles. It is therefore necessary for SCDOT materials and research engineers to have a sound understanding of the fundamental statistical principles on which such decisions are based.

To facilitate this understanding of fundamental statistical principles, the following major tasks were addressed in this project:

- ◆ Identify SCDOT's training needs regarding statistical concepts.
- ◆ Develop analysis guidelines for the identified statistical concepts.
- ◆ Develop and offer training workshops on each of the statistical guidebooks developed.

## METHODOLOGY

**Identify Statistical Concepts.** The first step was to establish a "Statistics Team" composed of SCDOT personnel selected by the Research and Materials Engineer in consultation with the principal investigator (PI). The team served as a primary resource for determining for which statistical concepts guidebooks needed to be developed and training needed to be offered. The PI met with three different groups of SCDOT personnel to identify the types of statistical analyses that they typically encountered in their activities. The discussions from these meetings, along with input from the Statistics Team, were used to identify the types of statistical guidelines to develop, as well as a general order of priority.

After reviewing the summaries of all of the interviews, an outline of topics for which statistical guidelines would be developed was prepared. The topics selected for the development of statistical guidelines are shown in Table 1.

**Table 1. Statistical Guidelines Developed**

No.	Title
1	Basic Concepts.
2	Graphical Presentation of Data.
3	Statistical Inferences on One-Sample Data.
4	Statistical Inferences on Two-Sample Data.
5	Goodness of Fit Tests.
6	Identifying Outliers.
7	Time Series Data and Control Charts.
8	Regression Analysis.
9	Experimental Design.
10	PWL Specifications: Limits and Payment.
11	PWL Specifications: Risks.

**Prepare Statistical Guidelines.** The PI and the graduate research assistant (GRA) prepared the draft guidelines. For some guideline the GRA developed the initial draft for review by the PI, who then prepared the final draft and added examples specific to SCDOT applications. For other guidelines the PI prepared the first draft, which was reviewed by the GRA before the PI prepared the final draft.

In a number of the guidelines dealing with hypothesis testing concepts, extensive use of both computational analysis and computer simulation was used to develop the power curves and operating characteristic (OC) curves that are presented.

The guidelines were prepared to serve as more than just “cookbooks” or procedures manuals, but also incorporated the basic underlying statistical concepts to support the procedures included in the guidelines. The guidelines include numerous everyday examples in addition to specific examples related to research and materials functions.

**Offer Statistical Training.** The PI developed and taught several statistical training workshops that covered each of the statistical guidelines that were

developed. The workshops were presented in a practical manner, with “hands on” workshop problems that were solved by the participants. In addition to “everyday” examples, a number of the examples and workshop problems were similar to the situations that the engineers encounter in their jobs. The initial basic statistical training was conducted October 4 and 5, 2005 (guidelines 1-4), with additional one-day training sessions held on October 11 (guidelines 5-7), 18 (guidelines 8-9), and 25 (guidelines 10-11).

**Develop a Procedures Manual.** The Statistics Team decided that for some common analyses it would be useful to have more specific step-by-step instructions regarding how to use Excel to perform the analyses. So, an Excel procedures manual was developed to present the step-by-step procedures to perform selected analyses. The analyses that were selected for inclusion met two criteria. First, they needed to be analyses that would be done on a fairly common basis; and second, they needed to be analyses that could be followed with only limited reference to the underlying statistical concepts in the guidelines.

The Excel procedures manual that was developed included procedures for the following analyses:

- ◆ Comparing Two Independent Samples.
- ◆ Comparing Results from Split Samples.
- ◆ Comparing Sample Results to a Standard or Target Value.
- ◆ Fitting a Line to a Set of (X, Y) Data.

### **OBSERVATIONS**

The process of using a Statistics Team and interviews to determine the guidelines to develop was effective and efficient. From the training sessions the guidebooks appeared to be written at an appropriate level for engineering and materials engineers. While much more difficult to schedule, a longer series of 2- to 4-hours workshops might have made it easier to comprehend the large amount of information involved in the training sessions.