STATISTICAL ANALYSIS PROGRAM FOR GENERATING MATERIAL ALLOWABLES

Suresh Keshavanarayana
Department of Aerospace Engineering
Wichita State University

A Center of Excellence
AMTAS
Advanced Materials in Transport Aircraft Structures

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CECAM center of excellence for composites and advanced materials

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Statistical Analysis Program For Generating Material Allowables

- Motivation and Key Issues
  - Material Allowable generation methods & Computer programs
    - Single point method
      - STAT-17 (Fortran, Excel Visual basic)
    - Pooling Method
      - ASAP (Excel Visual basic)
    - Regression Analysis
      - Fortran
    - CMH-17 method (combination of Single point and Pooling methods)
      - Could use STAT-17 & ASAP separately - time consuming/inefficient

Statistical Analysis Program For Generating Material Allowables

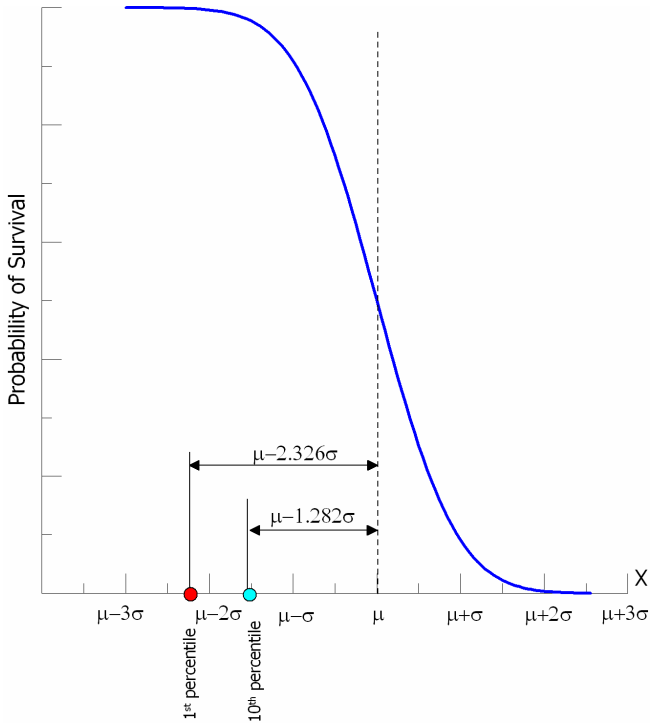
- Objective
  - Assemble a computer program to implement the CMH-17 procedure to generate material allowables.
  - Incorporate features of both STAT-17 and ASAP programs
  - Accommodate Batch processing of data
- Approach
  - Visual Basic program with Microsoft Excel user interface

FAA Sponsored Project Information

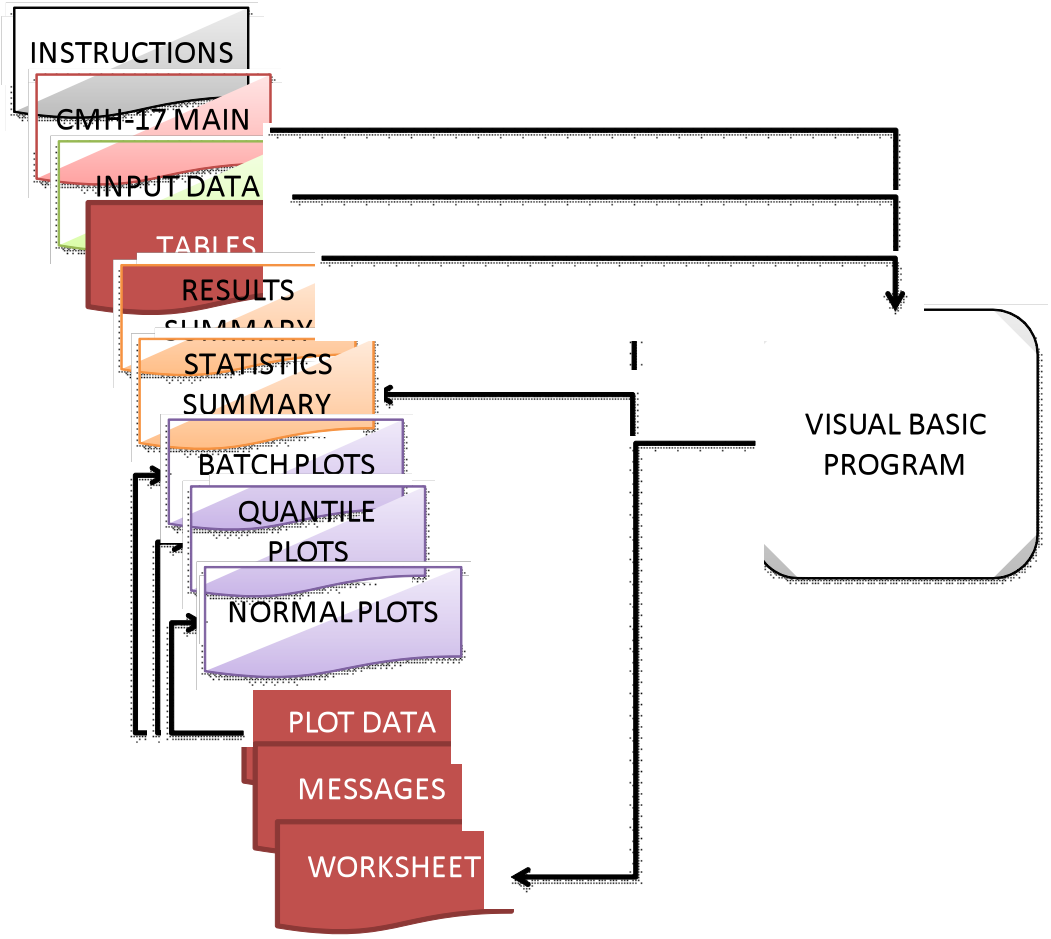
- Principal Investigators & Researchers
  - Suresh Keshavanarayana
  - Beth Clarkson
  - Md. Syed Seraz
- FAA Technical Monitor
  - Allan Abramowitz
- Other FAA Personnel Involved
  - Curtis Davies
- Industry Participation
  - through CMH-17 Statistics Working Group & NCAMP

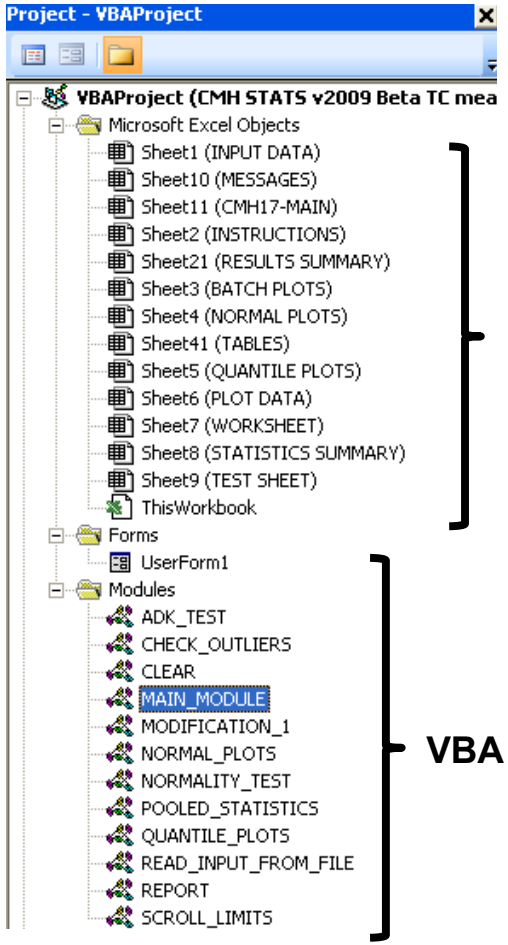
CMH-17 Procedure

- Combination of Single Point and Pooling methods
  - Single point method
    - Normal, Lognormal, Weibull distributions and Nonparametric method
  - Pooling method
    - Normal distribution assumed
  - Statistical tests
    - Outliers, between-batch variability, tests for distributions, equality of variances, etc.
    - Engineering judgment – Graphical tools



VBA Project Outline





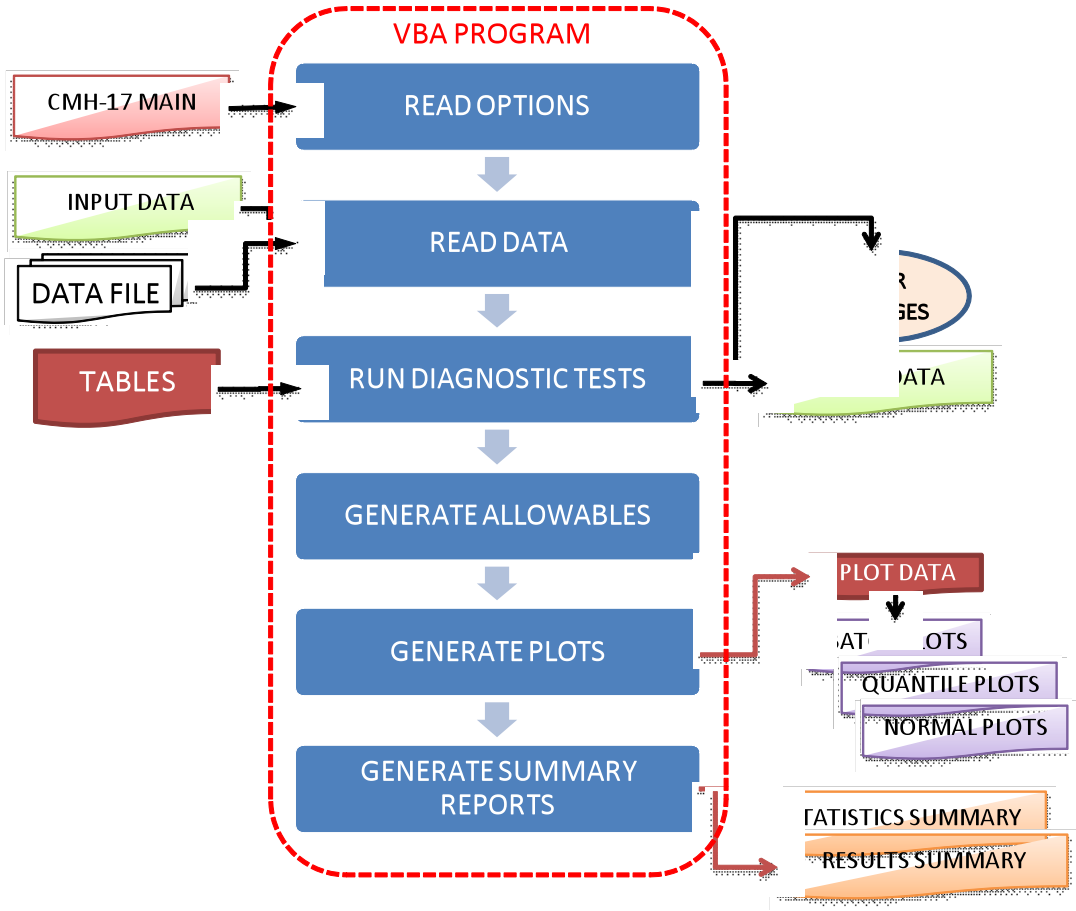
worksheets

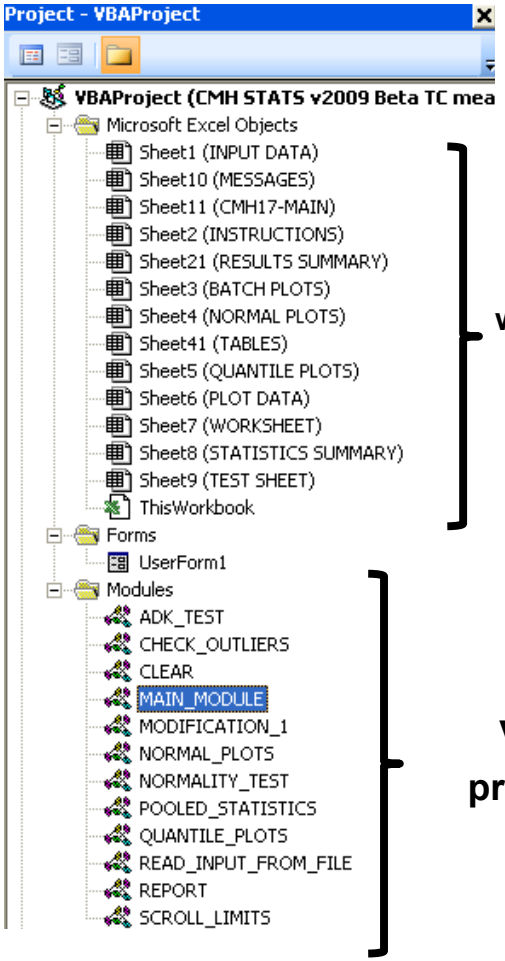
VBA program

VBA Project features

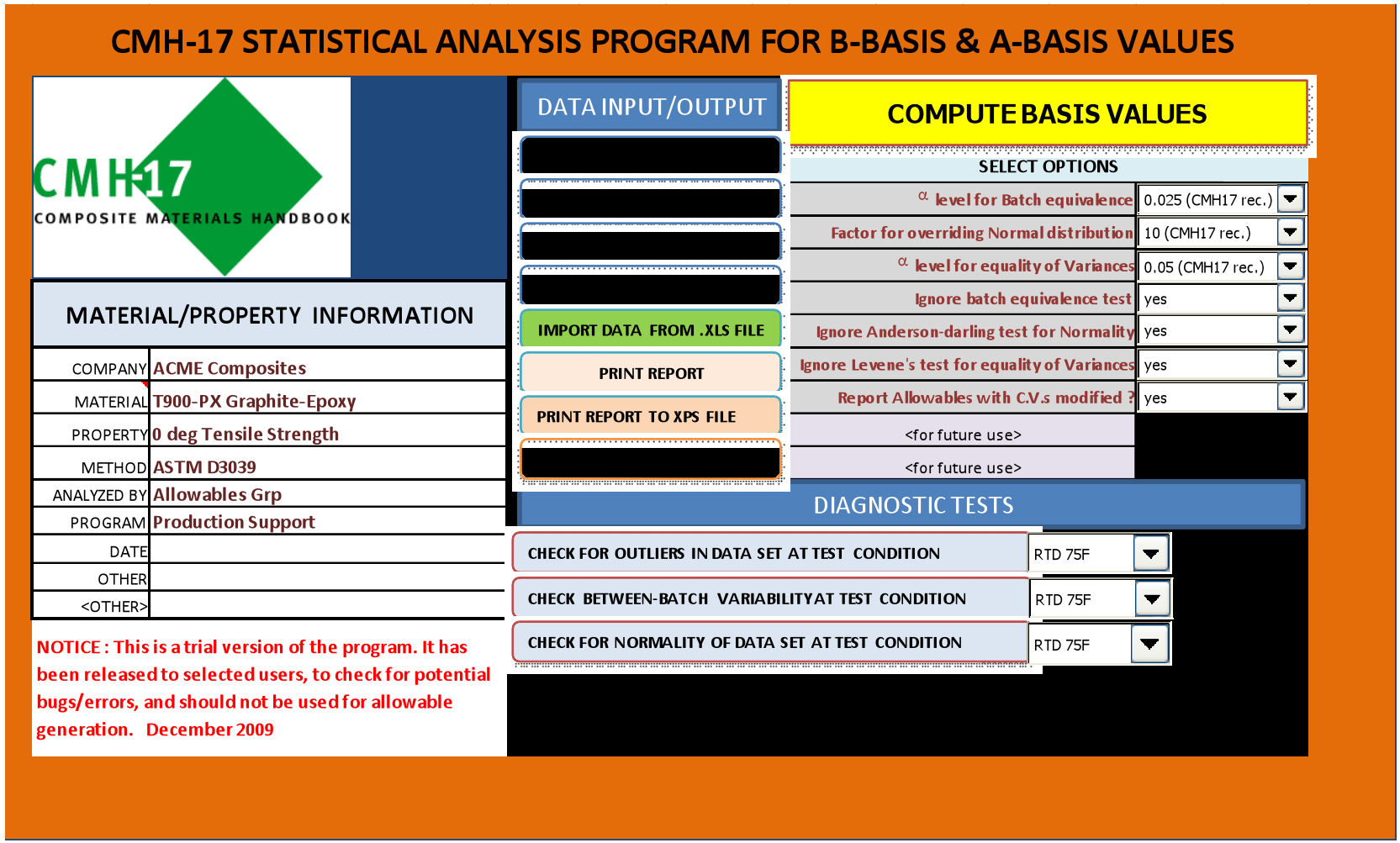
- Analyze data at up to 10 test environments
  - 500 data points per environment (expandable)
  - No limit on number of batches
  - Data input through excel spreadsheet / read from workbook(s)
- Diagnostic tests on user selected data sets
- Statistical test options (e.g., significance levels)
- Interactive
- Error messages
- Plots created at run-time
- Reports

VBA Program

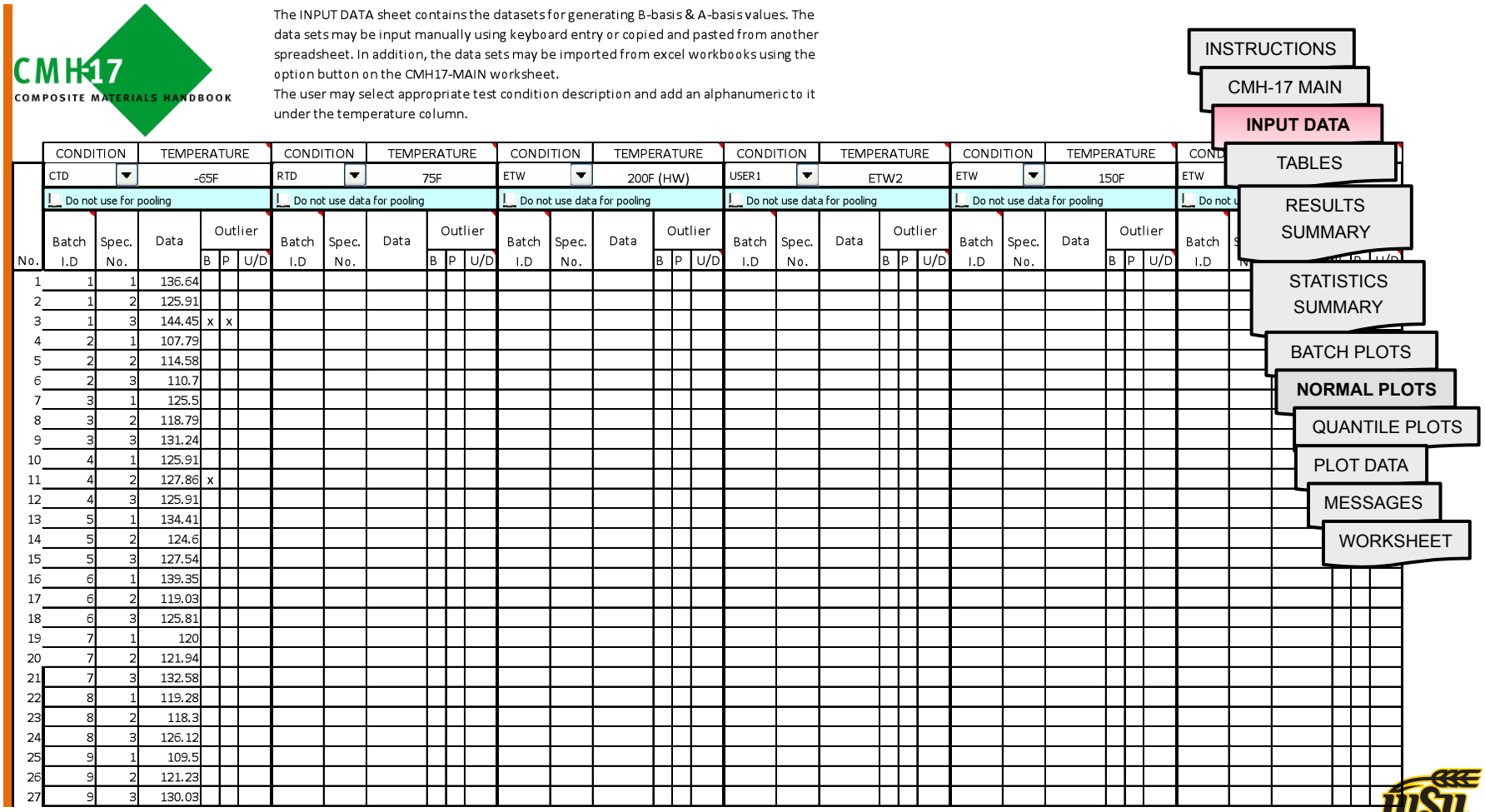

VBA PROGRAM
CMH-17 MAIN
INPUT DATA
DATA FILE
TABLES
READ OPTIONS
READ DATA
RUN DIAGNOSTIC TESTS
GENERATE ALLOWABLES
GENERATE PLOTS
GENERATE SUMMARY REPORTS
PLOT DATA
QUANTILE PLOTS
NORMAL PLOTS
RESULTS SUMMARY


Project - VBAProject
VBAProject (CMH STATS v2009 Beta TC mea
Microsoft Excel Objects
Sheet1 (INPUT DATA)
Sheet10 (MESSAGES)
Sheet11 (CMH17-MAIN)
Sheet2 (INSTRUCTIONS)
Sheet21 (RESULTS SUMMARY)
Sheet3 (BATCH PLOTS)
Sheet4 (NORMAL PLOTS)
Sheet41 (TABLES)
Sheet5 (QUANTILE PLOTS)
Sheet6 (PLOT DATA)
Sheet7 (WORKSHEET)
Sheet8 (STATISTICS SUMMARY)
Sheet9 (TEST SHEET)
ThisWorkbook
Forms
UserForm1
Modules
ADK_TEST
CHECK_OUTLIERS
CLEAR
MAIN_MODULE
MODIFICATION_1
NORMAL_PLOTS
NORMALITY_TEST
POOLED_STATISTICS
QUANTILE_PLOTS
READ_INPUT_FROM_FILE
REPORT
SCROLL_LIMITS
worksheets
VBA program

Program Execution/Control



Program Input



CMH-17 COMPOSITE MATERIALS HANDBOOK

The INPUT DATA sheet contains the datasets for generating B-basis & A-basis values. The data sets may be input manually using keyboard entry or copied and pasted from another spreadsheet. In addition, the data sets may be imported from excel workbooks using the option button on the CMH17-MAIN worksheet.
The user may select appropriate test condition description and add an alphanumeric to it under the temperature column.

INSTRUCTIONS
CMH-17 MAIN
INPUT DATA
TABLES
RESULTS SUMMARY
STATISTICS SUMMARY
BATCH PLOTS
NORMAL PLOTS
QUANTILE PLOTS
PLOT DATA
MESSAGES
WORKSHEET

	CONDITION	TEMPERATURE					CONDITION	TEMPERATURE					CONDITION	TEMPERATURE					CONDITION	TEMPERATURE					CONDITION	TEMPERATURE					COND
	CTD	-65F					RTD	75F					ETW	200F (HW)					USER1	ETW2					ETW	150F					ETW
	Do not use for pooling						Do not use data for pooling						Do not use data for pooling						Do not use data for pooling						Do not use data for pooling						Do not
No.	Batch I.D	Spec. No.	Data	Outlier B	Outlier P	Outlier U/D	Batch I.D	Spec. No.	Data	Outlier B	Outlier P	Outlier U/D	Batch I.D	Spec. No.	Data	Outlier B	Outlier P	Outlier U/D	Batch I.D	Spec. No.	Data	Outlier B	Outlier P	Outlier U/D	Batch I.D	Spec. No.	Data	Outlier B	Outlier P	Outlier U/D	Batch I.D	
1	1	1	136.64																											
2	1	2	125.91																											
3	1	3	144.45	x	x																									
4	2	1	107.79																											
5	2	2	114.58																											
6	2	3	110.7																											
7	3	1	125.5																											
8	3	2	118.79																											
9	3	3	131.24																											
10	4	1	125.91																											
11	4	2	127.86	x																										
12	4	3	125.91																											
13	5	1	134.41																											
14	5	2	124.6																											
15	5	3	127.54																											
16	6	1	139.35																											
17	6	2	119.03																											
18	6	3	125.81																											
19	7	1	120																											
20	7	2	121.94																											
21	7	3	132.58																											
22	8	1	119.28																											
23	8	2	118.3																											
24	8	3	126.12																											
25	9	1	109.5																											
26	9	2	121.23																											
27	9	3	130.03																											

Wichita State University

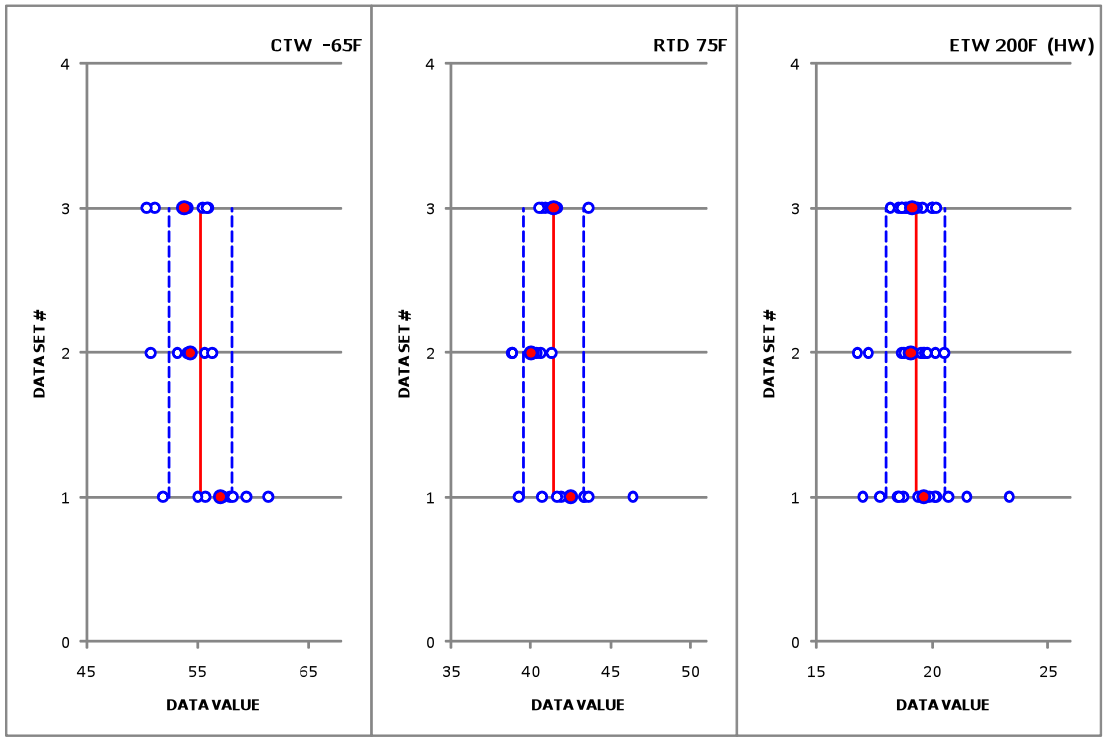
Batch Plots

TRIAL VERSION; DO NOT USE FOR ALLOWABLE GENERATION. DECEMBER 2009

CMH-17 COMPOSITE MATERIALS HANDBOOK

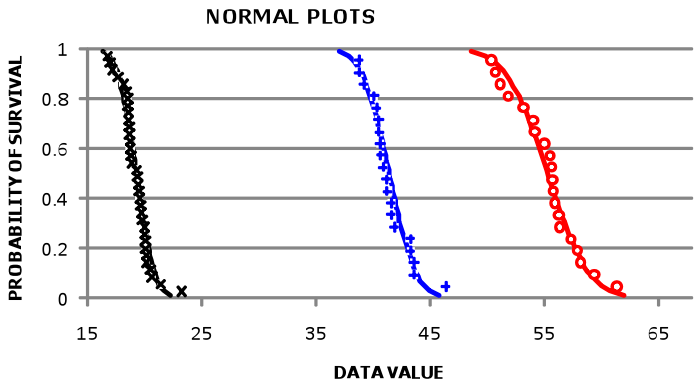
COMPANY: ACME Composites
MATERIAL : T900-PX Graphite-Epoxy
PROPERTY: 0 deg Tensile Strength
TEST METHOD: ASTM D3039
DATE: July 7, 2008

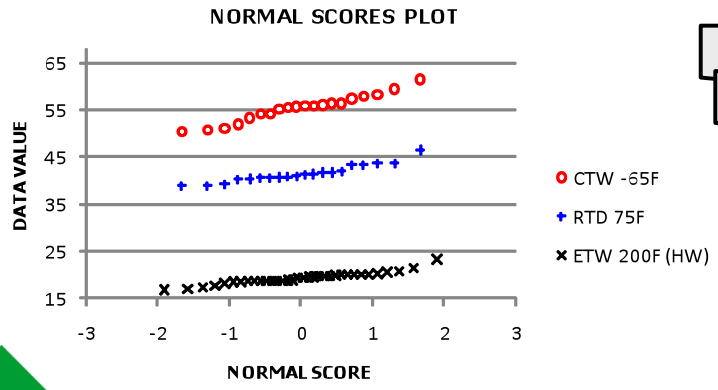
LEGEND
GROUP MEAN
+/- 1 STANDARD DEVIATION (GROUP)
DATA
BATCH MEAN

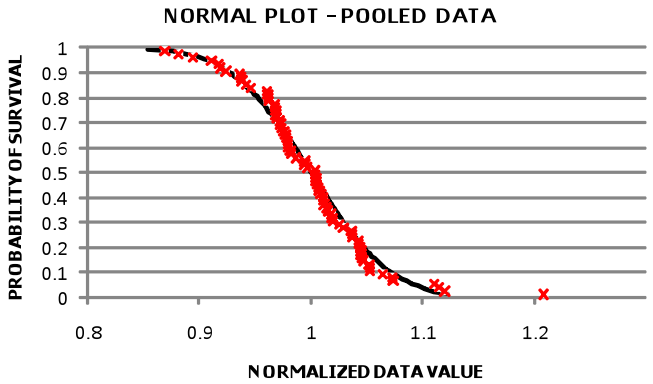


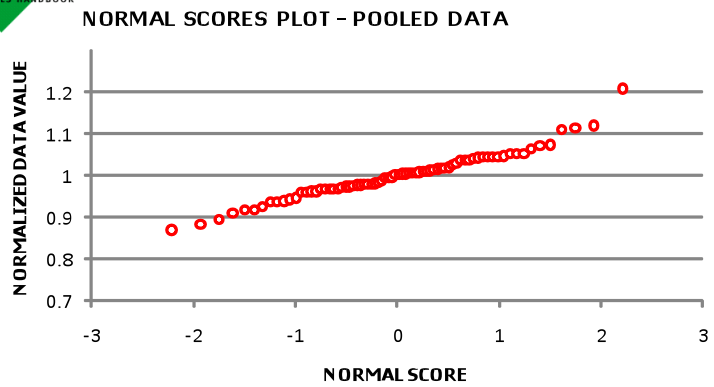
- INSTRUCTIONS
- CMH-17 MAIN
- INPUT DATA
- TABLES
- RESULTS SUMMARY
- STATISTICS SUMMARY
- **BATCH PLOTS**
- NORMAL PLOTS
- QUANTILE PLOTS
- PLOT DATA
- MESSAGES
- WORKSHEET

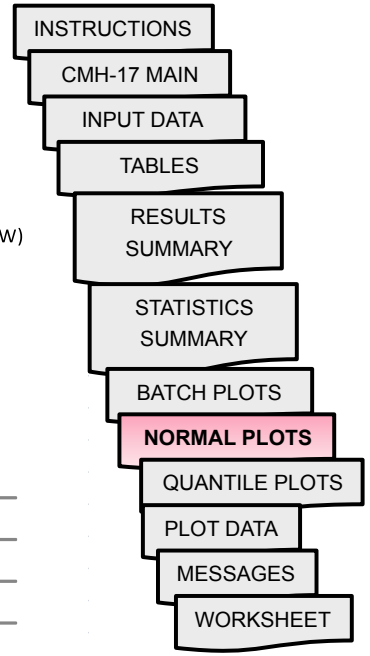
Normal Distribution Plots



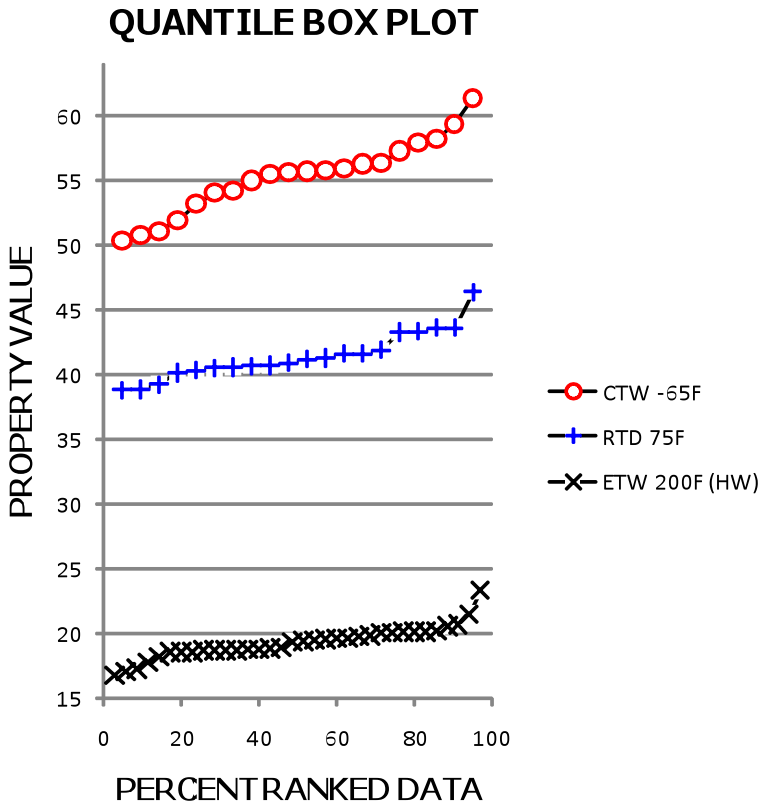


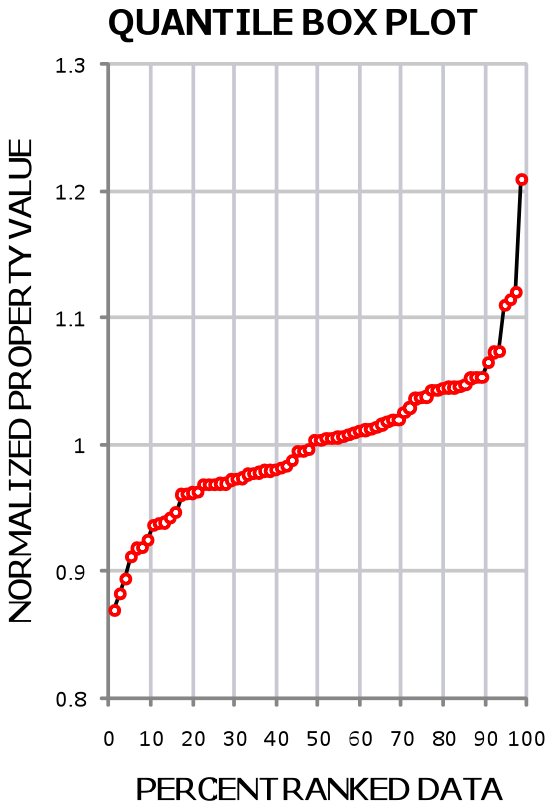


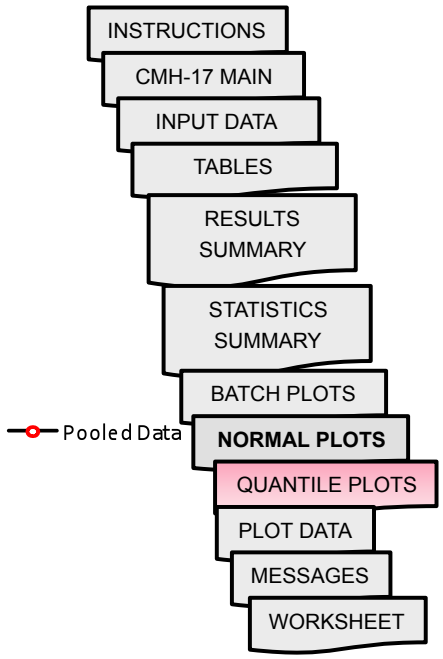




Quantile Plots







Program Status

- Trial version completed (Dec 2009)
  - Submitted to FAA WJHTC for approval
  - To be presented at CMH-17 meeting (July 10) for review
  - Testing under progress
    - Successfully completed tests using example problems in CMH-17 handbook
- Documentation
  - User's guide
  - Examples

A Look Forward

- Benefit to Aviation
  - A single program distributed & supported by the FAA to generate allowables in accordance with CMH-17 guidelines.
  - A repository of errors/upgrades to the program will be maintained through NCAMP
- Future needs
  - Integration of Regression method (RECIPE)