

# JAMS

## STATISTICAL ANALYSIS PROGRAM FOR GENERATING MATERIAL ALLOWABLES

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The Joint Advanced Materials and Structures Center of Excellence

# 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

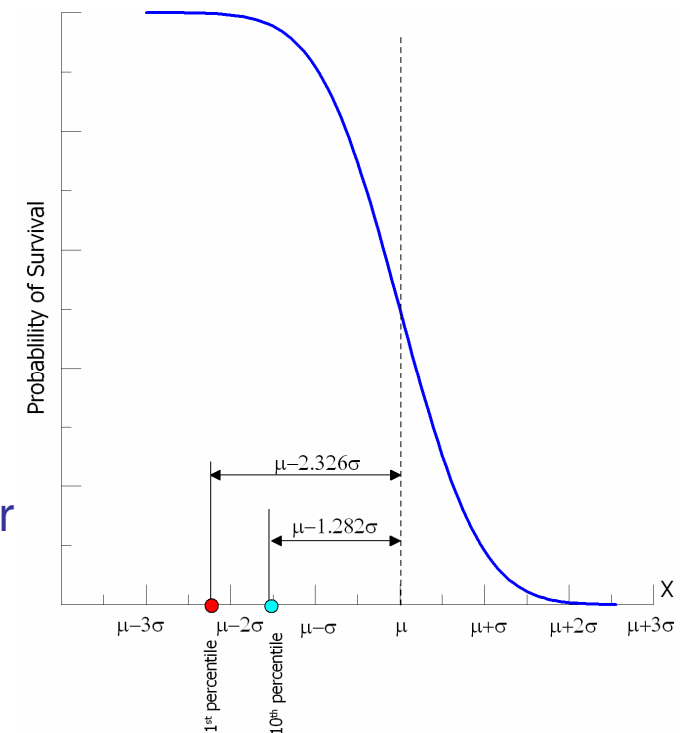


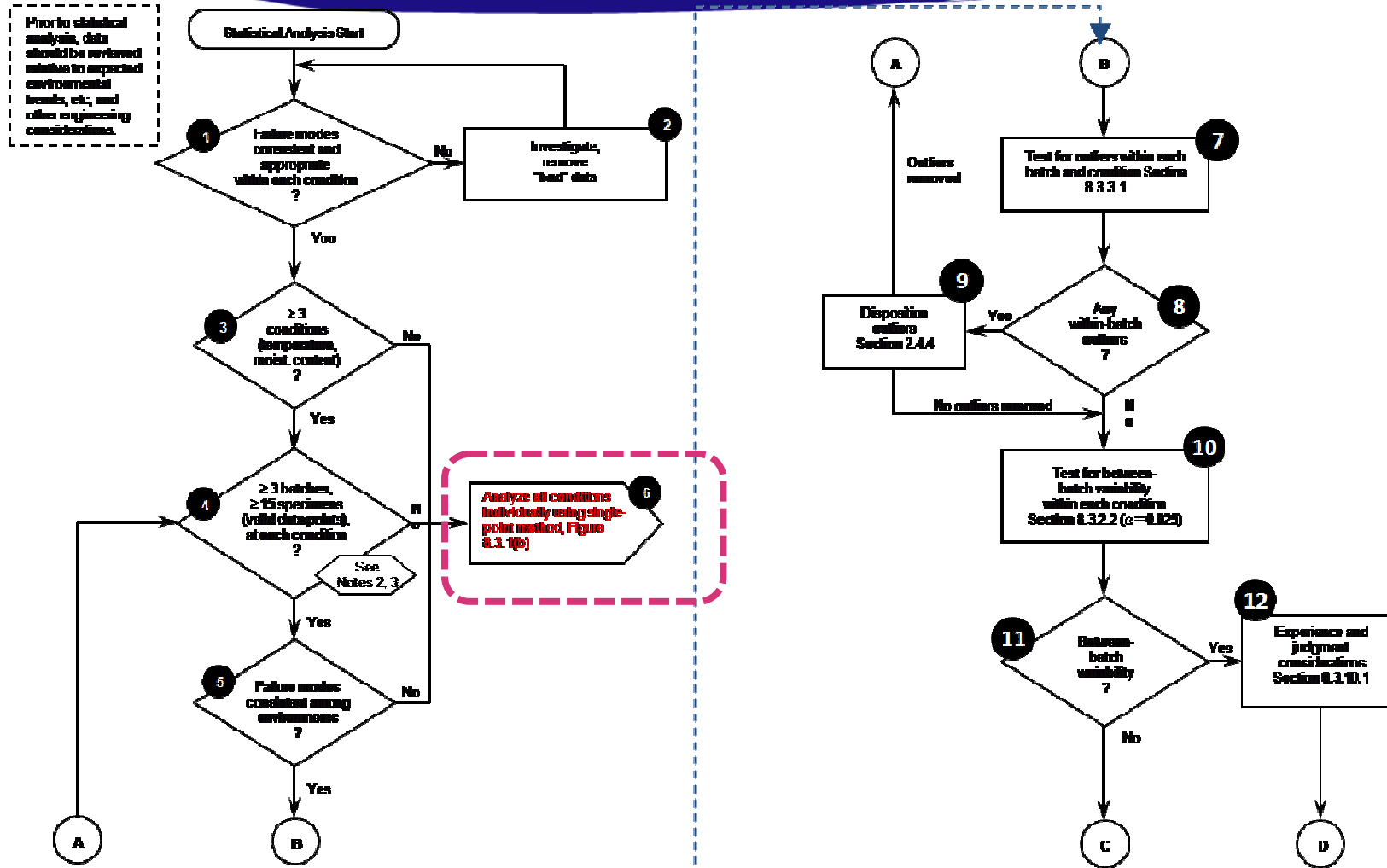
- Objective
  - Assemble a computer program to implement the CMH-17 procedure for generate material allowables.
  - Incorporate features of both STAT-17 and ASAP programs
  - Accommodate Batch processing of data
- Approach
  - Visual Basic program with Microsoft Excel user interface

# FAA Sponsored Project Information

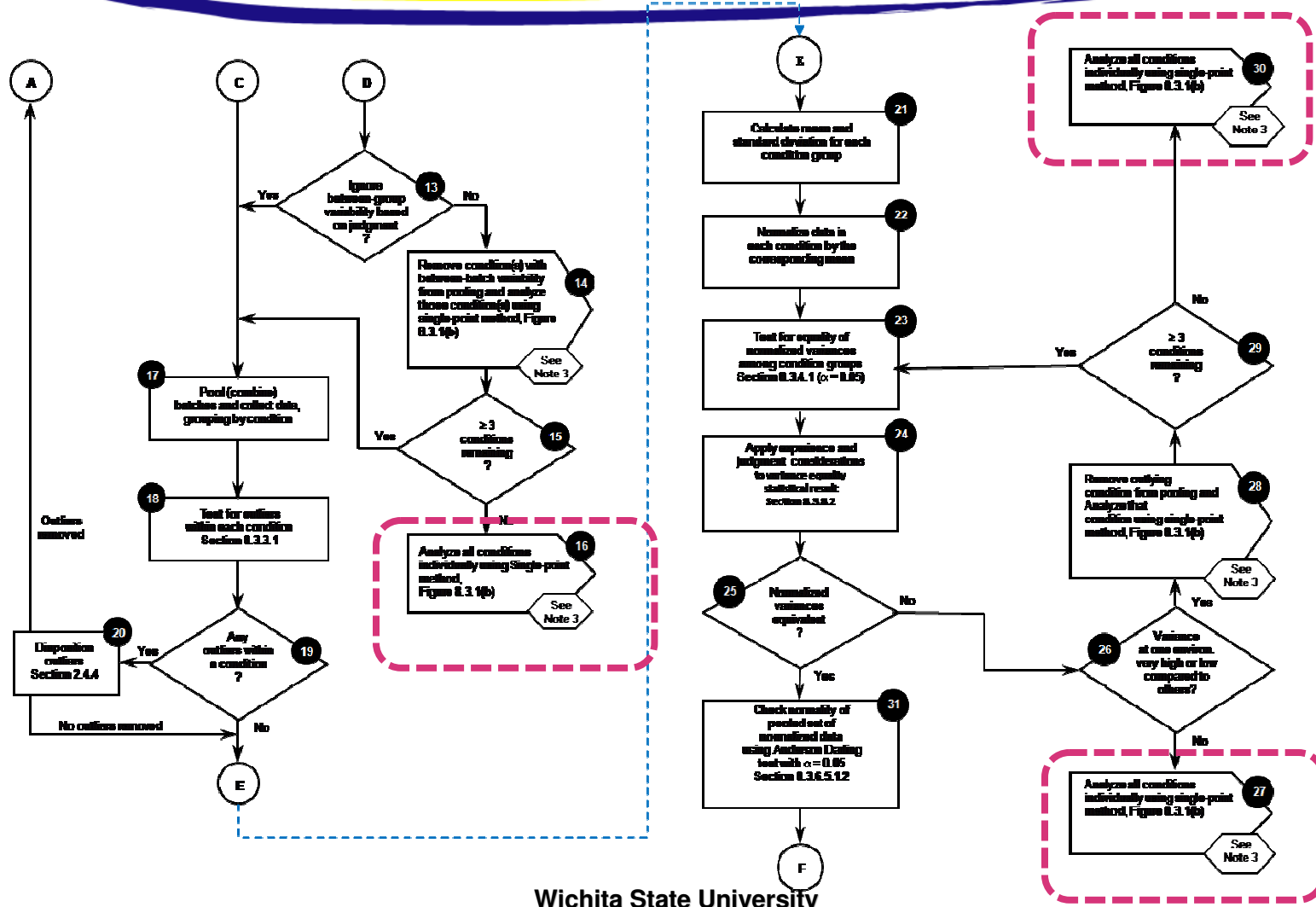
- Principal Investigators & Researchers
  - Suresh Keshavanarayana
  - Beth Clarkson (NIAR/NCAMP)
- FAA Technical Monitor
  - A. Abramowitz
- Other FAA Personnel Involved
  - C. Davies
- Industry Participation
  - through CMH-17 Statistics Working Group & NCAMP

- 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

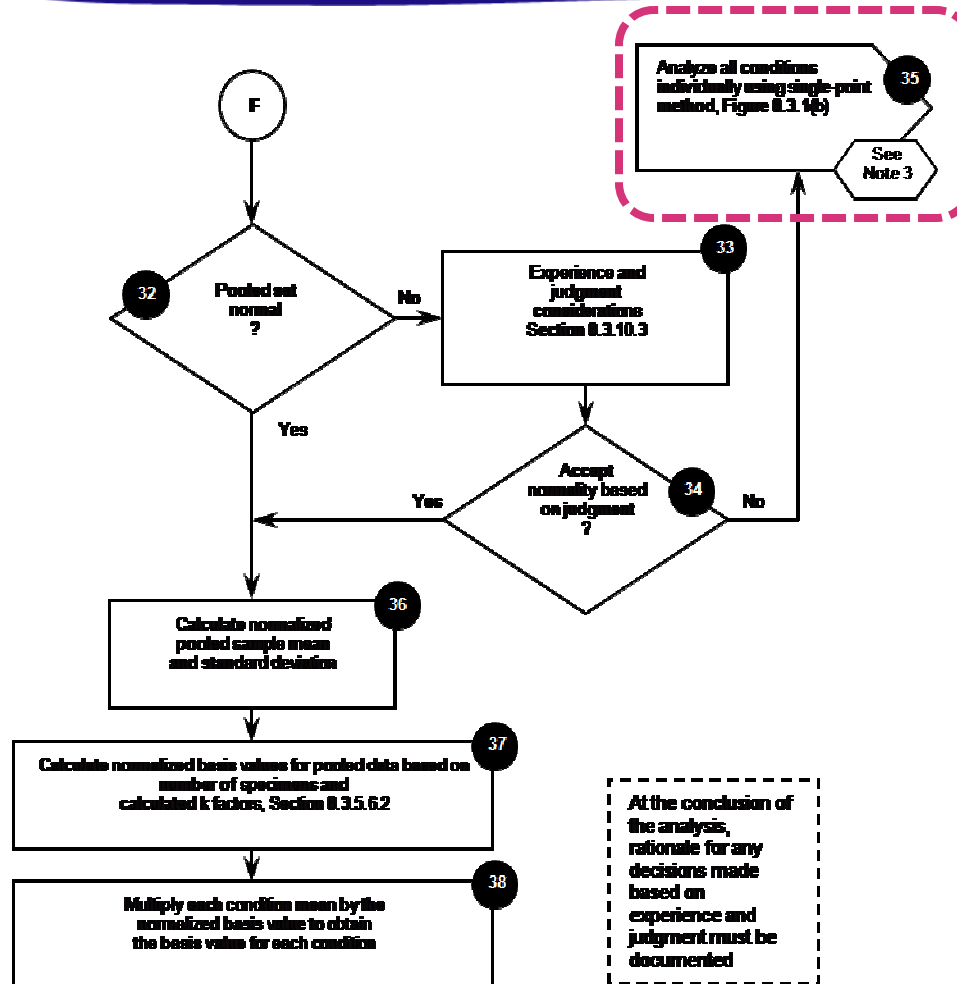




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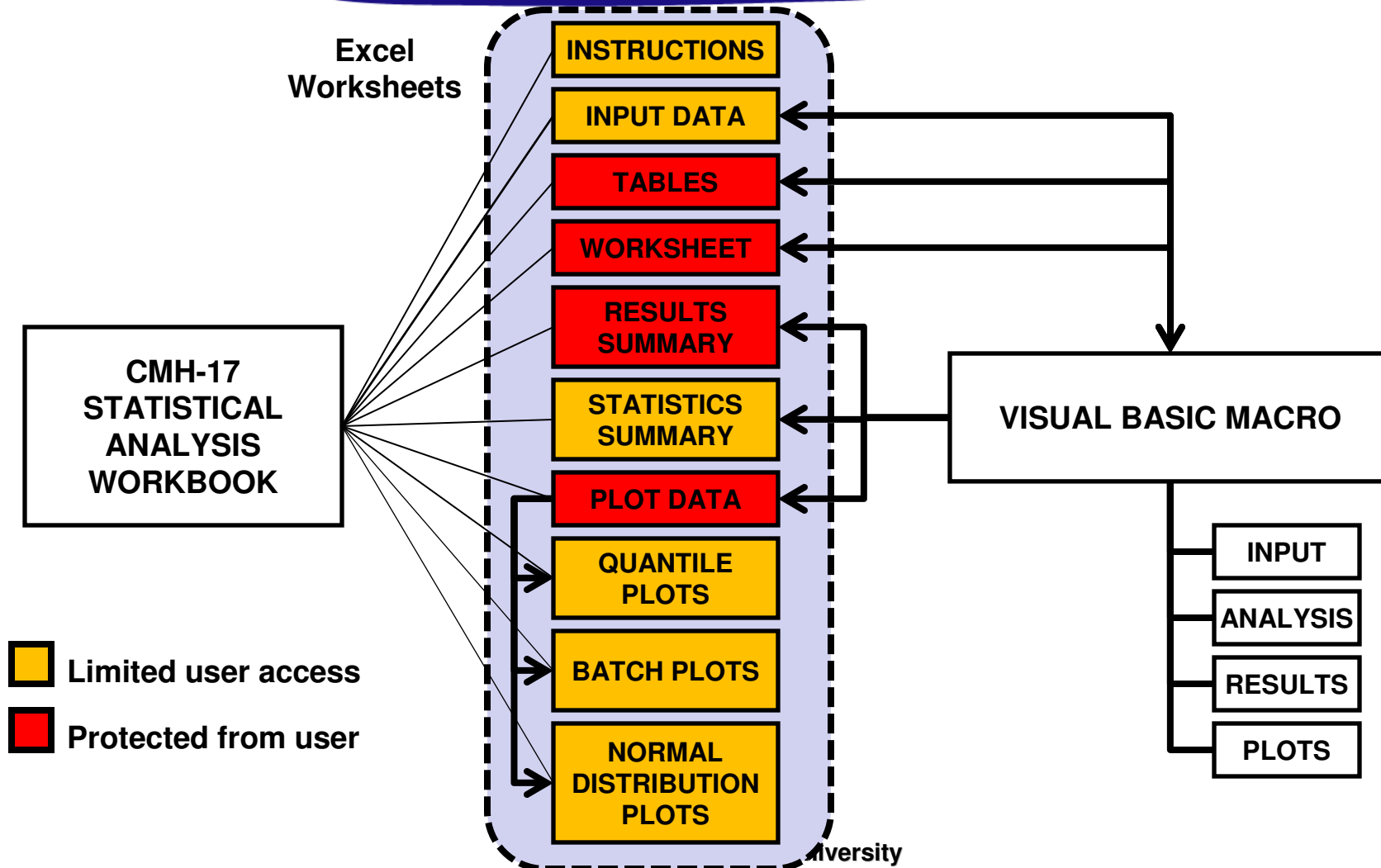


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- Program Requirements
  - Excel Visual Basic
  - 10 test environments
  - 50 batches & sample size of 1000 at each test environment
  - Ability to process data from multiple files/worksheets
  - Perform certain (outliers, between-batch variance) statistical tests prior to allowable generation
  - Generate basis values using both Pooling & Single Point method for comparison (comments generated by program should guide the user to make a proper choice per the CMH-17 procedure)
  - Program documentation to facilitate future changes/additions
  - Detailed user guide with examples



- Typical data sets
  - Multiple batches
  - Multiple test conditions
  - Specimen I.D's
  - Outliers

Test No.	Batch I.D.	Specimen No.	Data
1	A1	1	120.2
2	A1	2	112.4
3	A1	3	115.8
4	A1	4	123.2
5	B3	1	116.0
6	B3	2	110.2
7	B3	3	105.6
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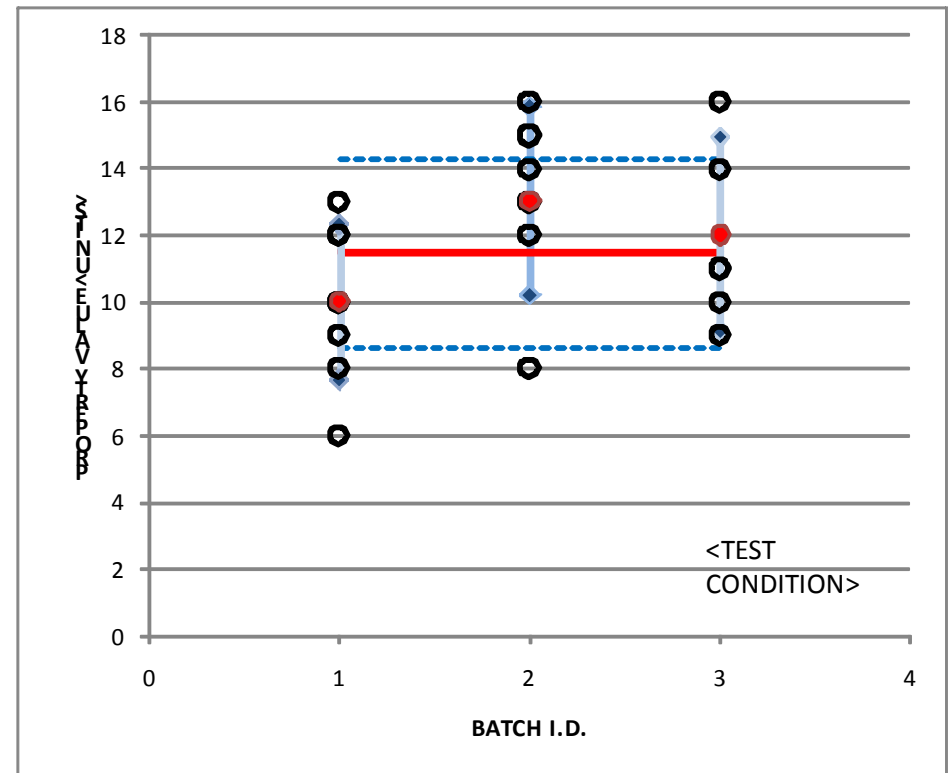
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MACRO  
BUTTONS

OUTLIERS

## BATCH PLOTS

- Plots of batch I.D. vs data values
  - Batch I.D.s could be alphanumeric, but the program will number the batches in the order of input
- Pooled/group mean, standard deviation plotted for comparison
- User will be allowed to alter the x & y scales of the plots
- 10 plots on a single worksheet. Hardcopies will have 2 sheets with 4 and 6 plots each.



COMPANY	
MATERIAL	
PROPERTY	
TEST METHOD	
DATE	July 7, 2008

STATISTIC	DATA SUMMARY									
	ENVIRONMENTAL TEST CONDITION									
	EC #1	EC #2	EC #3	EC #4	EC #5	EC #6	EC #7	EC #8	EC #9	EC #10
Sample Size	19	28	18	20	30	19	28	18	20	
No. of Batches	3	3	3	3	6	3	3	3	3	
Mean	137.39	141.31	134.53	130.57	125.00	137.39	141.31	134.53	130.57	160.00
Std.Dev	8.81	8.86	8.07	7.88	5.10	8.81	8.86	8.07	7.88	
% Co. Variation	6.42	6.27	6.00	6.04	4.00	6.42	6.27	6.00	6.04	
Minimum	124.41	125.30	119.67	112.60	137.00	124.41	125.30	119.67	112.60	
Maximum	151.48	154.47	144.88	146.34	118.00	151.48	154.47	144.88	146.34	

SUMMARY OF BASIS VALUES FOR DATA POOLED ACROSS ENVIRONMENTAL TEST CONDITIONS										
Pooled % Co.V	6.08									
$K_b$	1.7229	1.6623	1.7325	1.7140		1.7229	1.6623	1.7325	1.7140	
$K_a$	2.8597	2.8089	2.8679	2.8521		2.8597	2.8089	2.8679	2.8521	

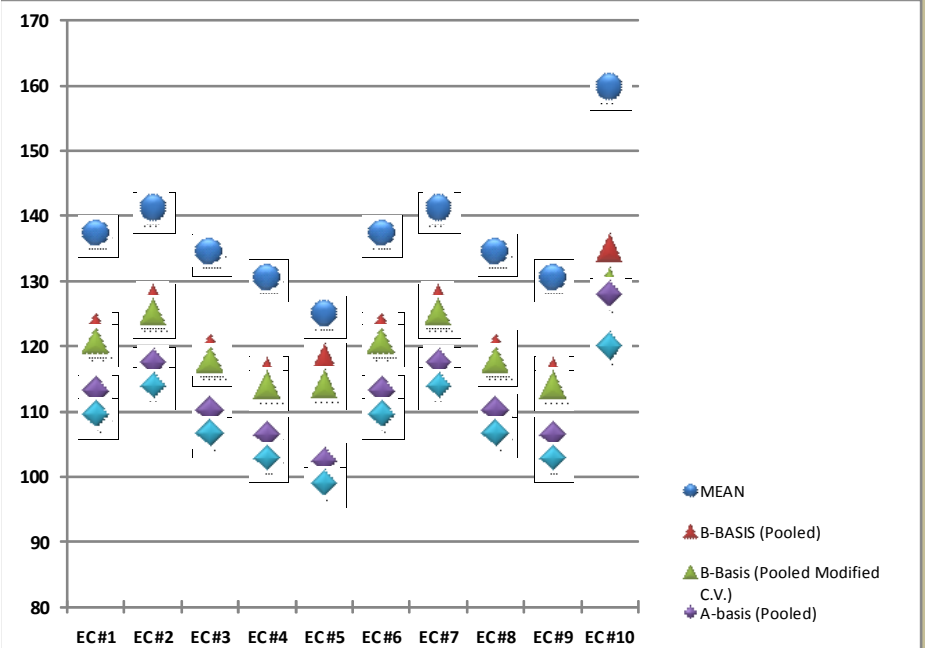
Equal C.V. Basis Values (Original Data)										
B-Basis Value	122.80	127.23	119.86	116.06	118.10	122.80	127.23	119.86	116.06	135.00
A-Basis Value	113.18	117.53	110.25	106.42	102.50	113.18	117.53	110.25	106.42	128.00

Modified %C.V	7.21	7.13	7.00	7.02		7.21	7.13	7.00	7.02	
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Equal C.V. Basis Values (Modified C.V)										
B-Basis Value	120.69	125.19	117.73	113.95	114.20	120.69	125.19	117.73	113.95	130.00
A-Basis Value	109.67	114.08	106.73	102.92	99.10	109.67	114.08	106.73	102.92	120.00

SUMMARY OF BASIS VALUES FOR DATA AT INDIVIDUAL ENVIRONMENTAL TEST CONDITIONS										
Distribution	Normal	Normal	Weibull	LogNormal	Non-Par					
B-Basis Value										
A-Basis Value	101	99	83	81	98					

COMMENTS										



COMMENTS										

Test Condition	1	2	3	4	5	6	7	8	9	10
Condition I.D.										
<b>Maximum Normed Residual Test for Outliers</b>										
Batch Level										
Pooled Data										
<b>Note : See INPUT DATA sheet for specific data points which have been identified as outliers</b>										
<b>k-Sample Anderson Darling Test for Batch Equivalence ADK &lt; ADC for equivalence</b>										
ADK										
ADC (a = 0.05)										
ADC (a = 0.025)										
ADC (a = 0.01)										
Same Population ?(a=0.025)										
<b>Modified CV Data - for pooling method</b>										
ADK										
Same Population ?(a=0.025)										
<b>Summary of Statistics for Pooling Method</b>										
<b>Anderson-Darling Test for Normality</b>										
O.S.L. (original data)										
Normality is										
O.S.L. (Modified data)										
Normality acceptable ?										
<b>Check for Normality Based on Graphical Method</b>										
Pearson Coefficient r										
Normality acceptable ?										
<b>Anderson-Darling Test for Normality of Pooled Data</b>										
O.S.L. for Original Data										
O.S.L. for Modified Data										
<b>Levene's Test for Equality of Variations ( F<sub>CALCULATED</sub> &lt; F<sub>CRITICAL</sub> for equivalence)</b>										
$\alpha =$	0.1	0.05	0.025	0.01						
F <sub>CRITICAL</sub>	2.153	2.717	3.282	4.033						
F <sub>CALCULATED</sub>	0.496									
F <sub>CALCULATED</sub> - Modified CV	ADK test fails! Data not modified									
<b>USER COMMENTS</b>										
1										
2										

<b>Summary of Statistics for Single-Point Method</b>											
Distribution	Statistic	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Normal	Observed Significance Level (OSL)										
Log Normal											
Weibull											
Normal	Mean										
	Stdev										
	%C.V.										
Log Normal	Log Mean										
	Log Stdev										
Weibull	Scale parameter										
	Shape Parameter										
<b>NON-PARAMETRIC STATISTICS</b>											
	B-Basis Method										
	A-Basis Method										
	B-Basis Rank										
	A-Basis Rank										
	B-Basis Hans-Koop k Factor										
	A-Basis Hans-Koop k Factor										
<b>EQUALITY OF VARIANCES TEST</b>											
	F <sub>calculated</sub>										
	F <sub>critical</sub>										
	Variances Equal ?										
<b>ANALYSIS OF VARIANCE (ANOVA) STATISTICS</b>											
	Sample Between-batch Mean Sq. (MSB)										
	Error Mean Square (MSE)										
	Estimate of Pop. Std. Deviation (S)										
	B-Basis Tolerance Limit Factor (TB)										
	A-Basis Tolerance Limit Factor (TA)										
	B-Basis Value										
	A-Basis Value										
<b>SUMMARY OF BASIS VALUES</b>											
B-Basis	WEIBULL										
	NORMAL										
	LOGNORMAL										
	NON-PARAMETRIC ANALYSIS OF VARIANCE										
A-Basis	WEIBULL										
	NORMAL										
	LOGNORMAL										
	NON-PARAMETRIC ANALYSIS OF VARIANCE										

- Excel user interface completed
- Visual basic Program
  - Data reading module completed
  - Analysis module under construction
- Expected completion date for trial version ~  
Nov.2009



- 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)