DfRSoft... Overview

Design for Reliability Software

for complete DfR Engineering

Thank You for your interest

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Summary of *DfRSoft*... Tools

- RELIABILITY SOFTWARE
- ·Reliability Plotting (Weibull etc.) ·Reliability Statistics ·MTBF Predictions ·System Reliability ·Acceleration Models ·Automated Qual Plans ·Accelerated Test Plans ·Derating Guidelines ·Design FMEA ·Parametric Reliability Analysis · Reliability Growth ·Environmental Profiling (CALT like analysis but easier to apply), Engelmaier BGA Fatigue Life Model
- QUALITY SOFTWARE
- ·SPC Control Charts ·Normal & Lognormal Probability Plotting ·Lot Sampling Plans ·Cpk -Six Sigma Yield Analysis ·Field Return Analysis ·Availability & Sparing
- PHYSICS OF FAILURE & DfRQ LIBRARY
- ·A Library of Analysis Tools, PoF Knowledge, Design Guidelines, and DfRQ Tests
- DfRQ ENGINEERING TOOLS
- · Vibration & Shock Analysis ·Thermal Analysis · Electrical Analysis · Corrosion Prevention · Misc Tools-DfRQ Cost Analysis · Engineering Conversions · Electrostatic Discharge Design & Guidelines · Skin Depth Engineering

FUNDAMENTAL INSTRUCTIONS

- Entries always go in GREEN AREAS ENTER

- POP-UPS Instructions are found in any difficult tool. They look like:

EXAMPLE **HELP** **COMMENT** **INSTRUCTIONS**

- Simply slide your curser on the word and the instructions will show up.

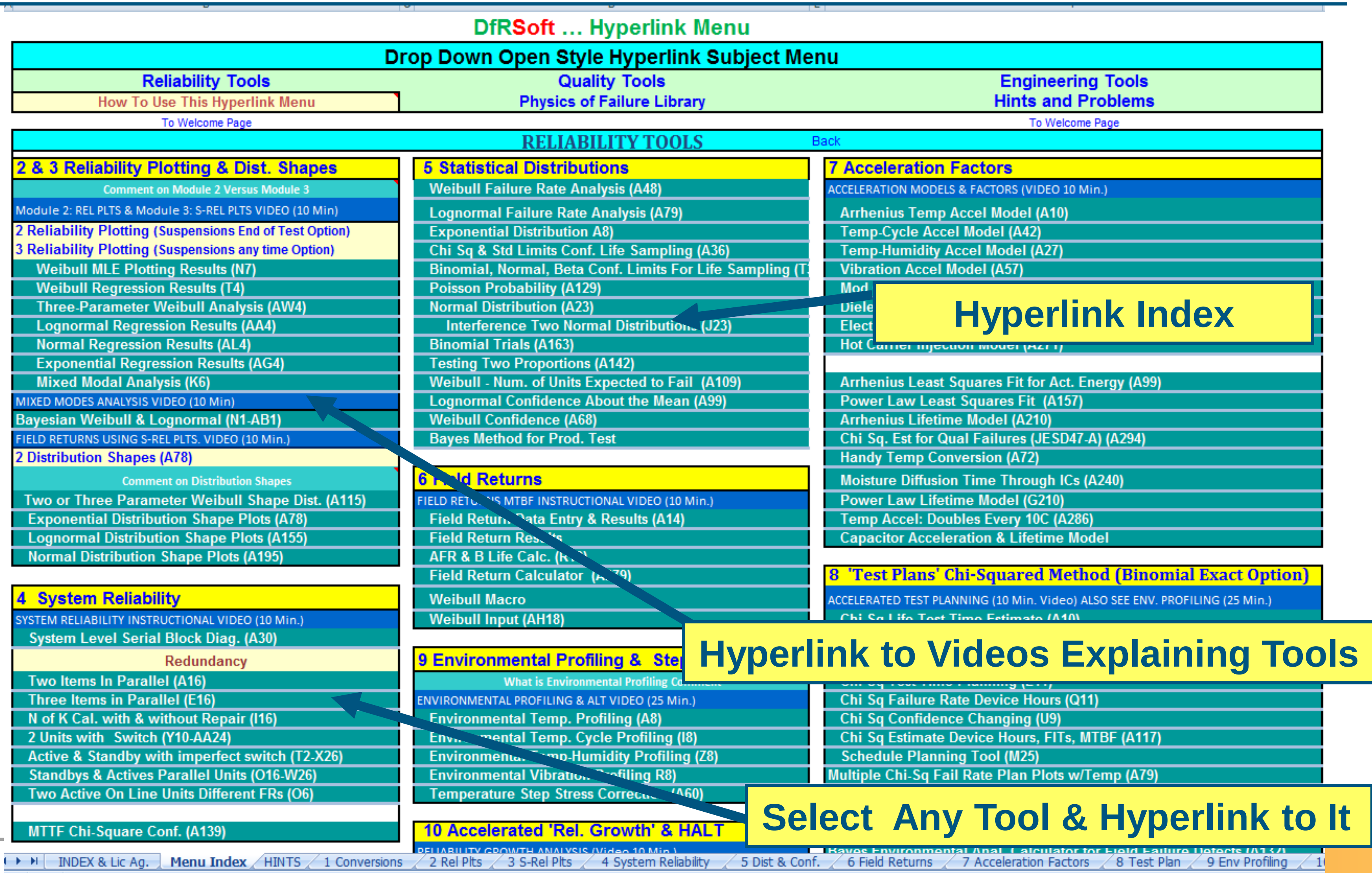
- Pop ups can be moved around and you can add your own comments. Simply right click on the pop up area and select edit comment.

DfRSoft's Welcome Page

Hyperlink Index To Menu Tools

DfRSoft Hyperlink Open Style Menu

How to Find DfR Tools & Videos: Simply use the DfRSoft Hyperlink Index



Why DfRSoft Users Never Call Us for Questions on Software Help

- Our Pop-up Instructions and Videos are so complete and helpful, our phone…..

  Never,

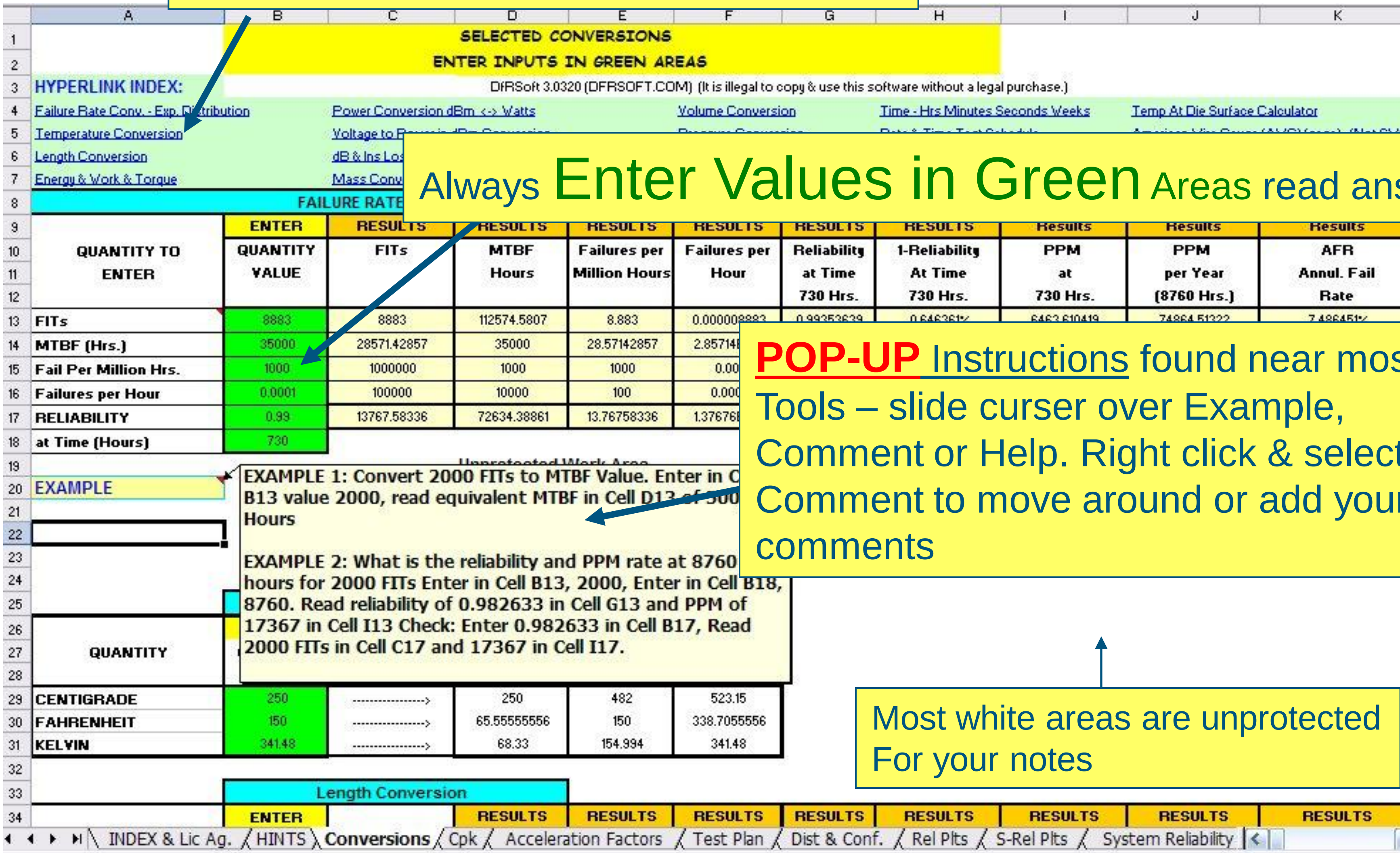
  Ever,

  Ever rings!!!

Conversion Worksheet

Example: How to use DfRSoft:

Hyperlink Index for Conversion worksheet



	A	B	C	D	E	F	G	H	I	J	K
1		SELECTED CONVERSIONS									
2		ENTER INPUTS IN GREEN AREAS									
3	HYPERLINK INDEX:	DfRSoft 3.0320 (DFRSOFT.COM) (It is illegal to copy & use this software without a legal purchase.)									
4	Failure Rate Conv. - Exp. Distribution		Power Conversion dBm <-> Watts			Volume Conversion		Time - Hrs Minutes Seconds Weeks		Temp At Die Surface Calculator	
5	Temperature Conversion		Voltage to Power in dBm Conversion			Pressure Conversion		Rate & Time Test Schedule		American Wire Gauge (AWG) (area) (Not SWG	
6	Length Conversion		dB & Ins Los								
7	Energy & Work & Torque		Mass Conv								
8		FAILURE RATE									
9		ENTER	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	Results	Results	Results
10–12	QUANTITY TO ENTER	QUANTITY VALUE	FITs	MTBF Hours	Failures per Million Hours	Failures per Hour	Reliability at Time 730 Hrs.	1-Reliability At Time 730 Hrs.	PPM at 730 Hrs.	PPM per Year (8760 Hrs.)	AFR Annul. Fail Rate
13	FITs	8883	8883	112574.5807	8.883	0.000008883	0.99353639	0.646361%	6463.610419	74864.51322	7.486451%
14	MTBF (Hrs.)	35000	28571.42857	35000	28.57142857	2.85714					
15	Fail Per Million Hrs.	1000	1000000	1000	1000	0.00					
16	Failures per Hour	0.0001	100000	10000	100	0.000					
17	RELIABILITY	0.99	13767.58336	72634.38861	13.76758336	1.37676					
18	at Time (Hours)	730									
19				Unprotected Work Area							
20	EXAMPLE										
27	QUANTITY										
29	CENTIGRADE	250	----------------->	250	482	523.15					
30	FAHRENHEIT	150	----------------->	65.55555556	150	338.7055556					
31	KELVIN	341.48	----------------->	68.33	154.994	341.48					
33		Length Conversion									
34		ENTER		RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS

EXAMPLE 1: Convert 2000 FITs to MTBF Value. Enter in C... B13 value 2000, read equivalent MTBF in Cell D13 of 500... Hours

EXAMPLE 2: What is the reliability and PPM rate at 8760 hours for 2000 FITs Enter in Cell B13, 2000, Enter in Cell B18, 8760. Read reliability of 0.982633 in Cell G13 and PPM of 17367 in Cell I13 Check: Enter 0.982633 in Cell B17, Read 2000 FITs in Cell C17 and 17367 in Cell I17.

INDEX & Lic Ag. | HINTS | Conversions | Cpk | Acceleration Factors | Test Plan | Dist & Conf. | Rel Plts | S-Rel Plts | System Reliability

Always Enter Values in Green Areas read answers

POP-UP Instructions found near most Tools – slide curser over Example, Comment or Help. Right click & select edit Comment to move around or add your own comments

Most white areas are unprotected For your notes

Current Conversion Worksheet

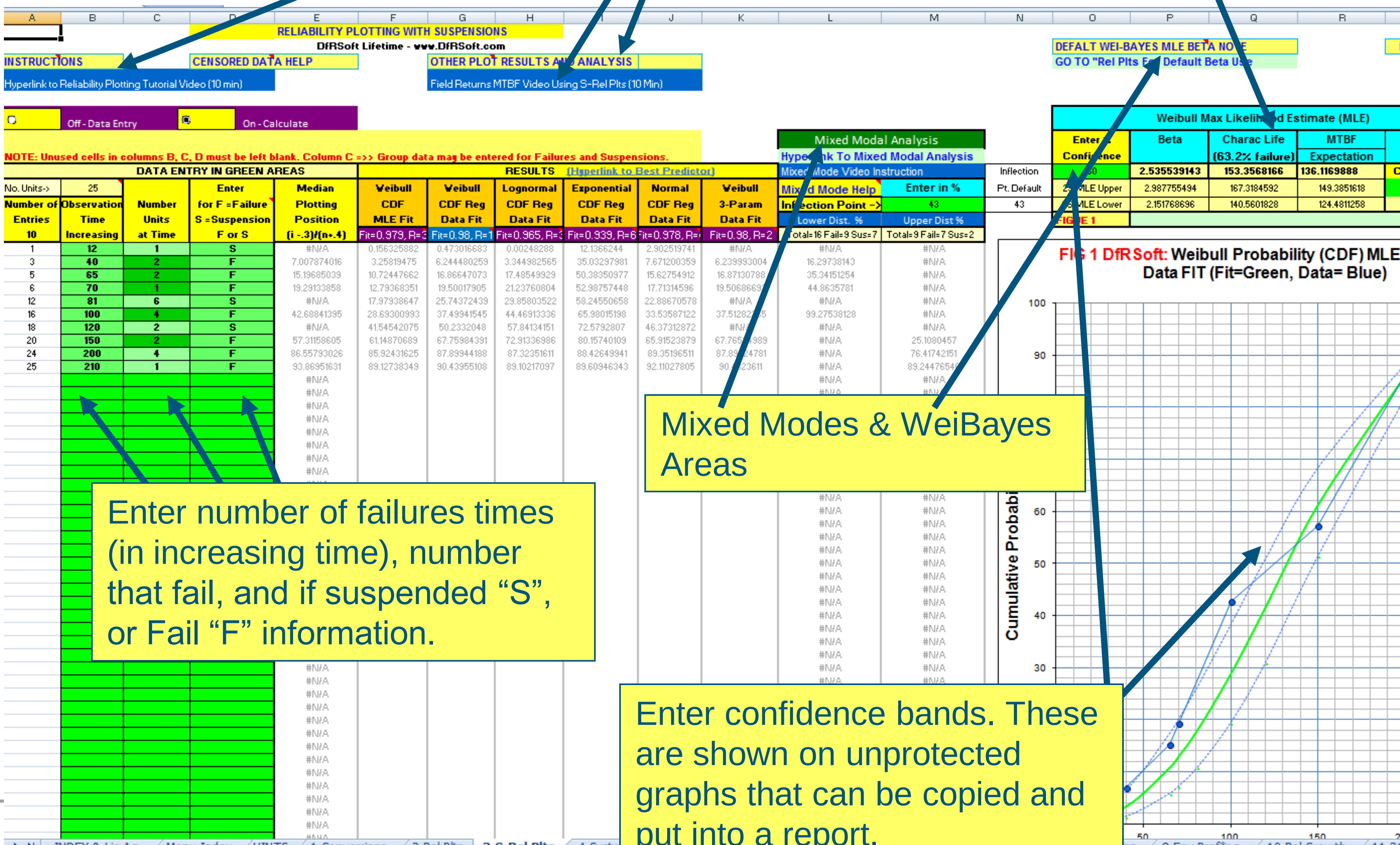
Reliability Plotting

(Software provides a simple way

for data entry and assessment of best fit dist)

Pop-up and Videos Instructions

Results of distribution parameters such as beta, MTBF found in this area with confidences

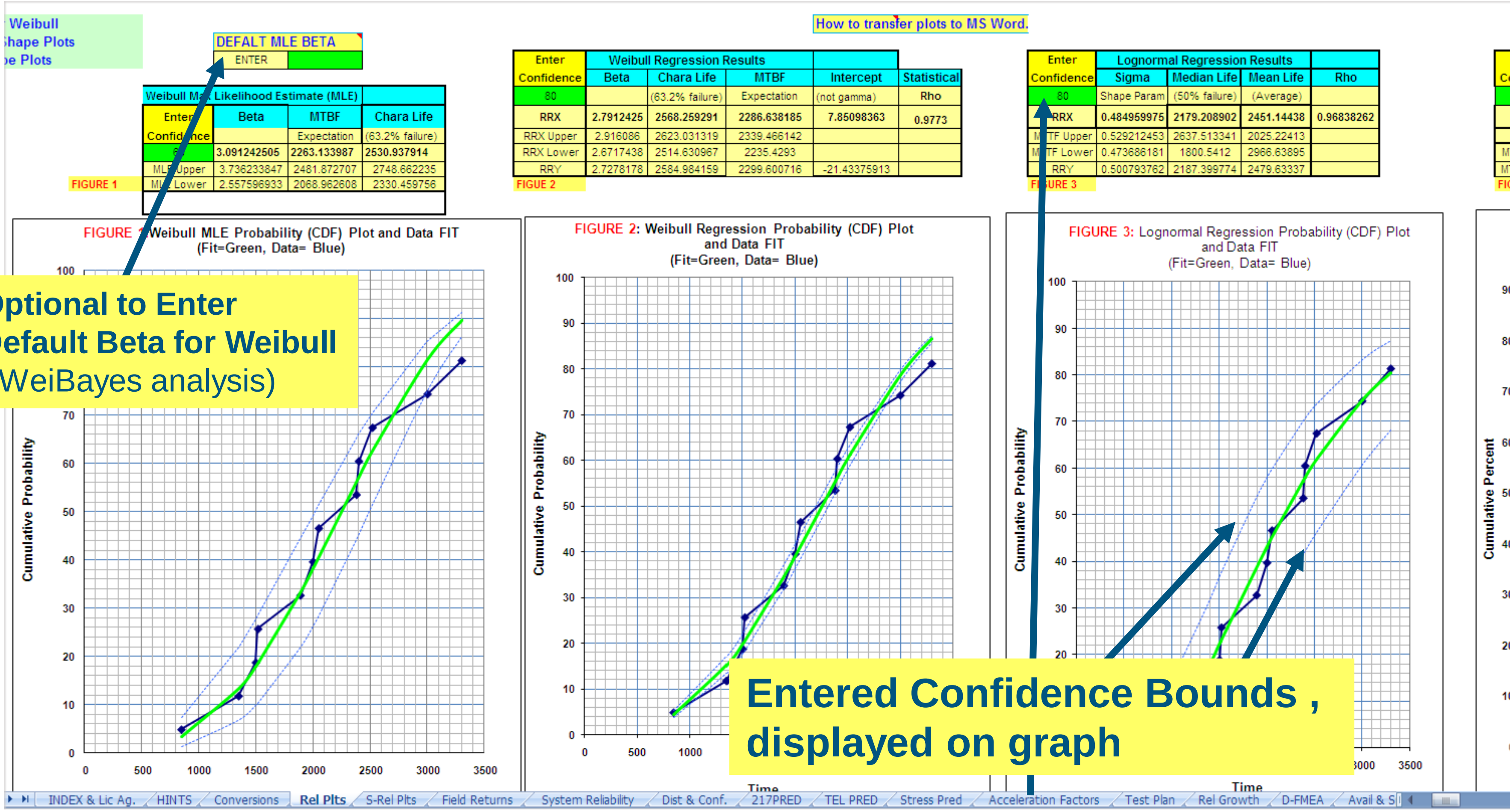


Mixed Modes & WeiBayes Areas

Enter number of failures times (in increasing time), number that fail, and if suspended “S”, or Fail “F” information.

Enter confidence bands. These are shown on unprotected graphs that can be copied and put into a report.

All Reliability Plots displayed next to each other



Optional to Enter Default Beta for Weibull (WeiBayes analysis)

Entered Confidence Bounds , displayed on graph

Assess best fit Weibull, Lognormal, Exponential, Normal
Both Weibull Regression on X or Y and MLE (Maximum Likelihood Estimation)

Reliability Plotting Analysis with Best Predictor

Quick analysis section to determine reliability at any time. For a full analysis use the distribution and confidence analysis area"

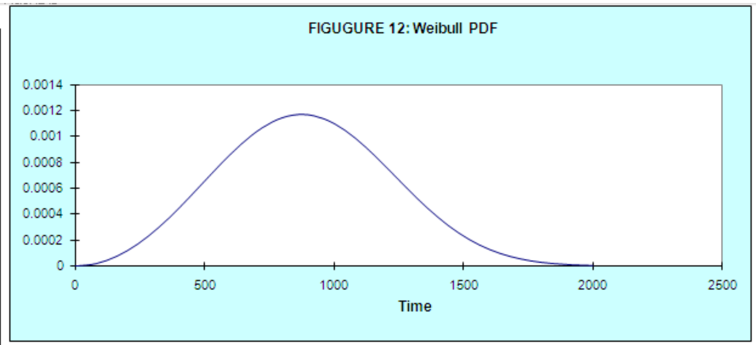
Optional Reliability Prediction Time	ENTER		MLE Weibull Prediction	Weibull Prediction	Lognormal Prediction	Exponential Prediction	Normal Prediction	3-Param Weibull
Enter Reliability 0< R <1	0.85	Time rrx -->	690.5746719	468.4774143	488.9642878	217.3037259	383.3759403	469.9514401
Confidence		Upper Time	928.7094774	817.4654089	523.0080496	350.8316097	471.087964	
Entered Above Plots		Lower Time	496.9905899	243.846064	428.4619475	134.5970773	211.2453228	
Enter Time of Interest	260	R Probability rrx	0.973631883	0.93354051	0.96594295	0.823286538	0.875857136	#NUM!
Confidence		Upper Prob	0.990385642	0.982289474	0.963501241	0.886528351	0.887194289	
Entered Above Plots		Lower Prob	0.941855279	0.839895244	0.956337866	0.730565492	0.837935563	
BEST PREDICTOR SECTION	Predictor Comment		Weibull MLE	Weibull Reg	Lognormal Reg	Exponential Reg	Normal Reg.	3-Param Weibull
Best Predictor Analysis for Median Plot Position			96.67450%	97.04189%	96.64243%	97.41469%	96.88096%	97.24427%
Rank of Predictor for Median Plot Position			5	3	6	1	4	2
Rank by Regression Rho values			NA	96.39377%	96.24409%	94.42535%	95.96018%	98.01312%
Rank by Linear Regression Goodness of Fit				2	3	5	4	1

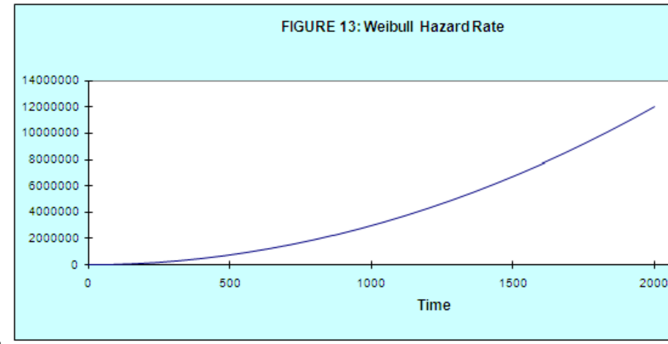
Best Predictor Ranks which distribution Best Fits the data (two methods)

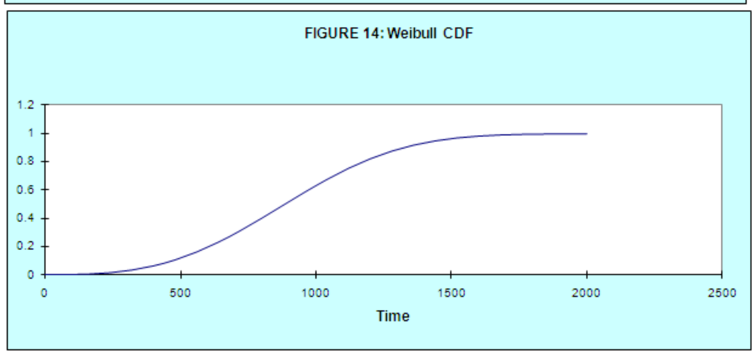
View Plots for Any Basic Distribution Over Any Time Period.

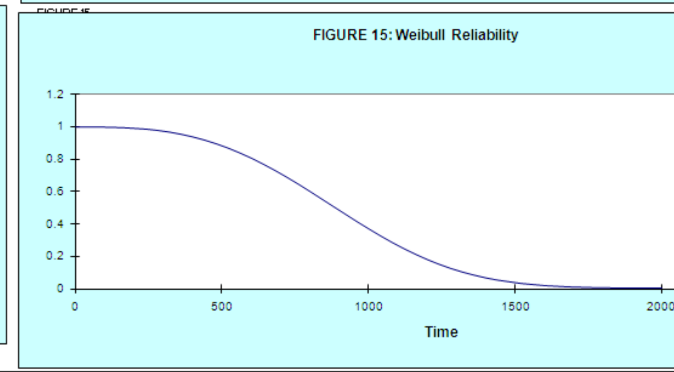
Two or Three Parameter Weibull Distribution Plots		
Parameter	**Enter**	Notes
Characteristic Life	1000	Time to 63.2% Failure
Shape Parameter (Beta)	3	Infant Mort.<1, Exp=1, Wear Out>1
3rd Parameter (Gamma)	0	Time shift, Usually 0
Plot Time Start	0	
Plot Time End	2000	

Time	PDF	CDF	Hazard Rate (FITS)	Reliability
0	0	0	0	1
80	1.91902E-05	0.000511869	19200	0.999488131
160	7.64861E-05	0.004087623	76800	0.995912377
240	0.000170428	0.013728887	172800	0.98627113
320	0.000297297	0.032236945	307200	0.967763055
400	0.000450242	0.061995	480000	0.938005
480	0.000618834	0.104696042	691200	0.895303958
560	0.000789275	0.161059926	940800	0.838940074
640	0.000945439	0.230599778	1228800	0.769400222
720	0.001070747	0.311505535	1555200	0.688494465
800	0.001150648	0.400704212	1920000	0.599295788
880	0.001175241	0.494128199	2323200	0.505871801
960	0.001141373	0.587176856	2764800	[illegible]
1040	0.001053576	0.675303377	3244800	[illegible]
1120	0.000923432	0.754615276	3763200	[illegible]
1200	0.000767402	0.822360666	4320000	[illegible]
1280	0.000603614	0.877194319	4915200	[illegible]
1360	0.000448488	0.919173953	5548800	[illegible]
1440	0.000314087	0.949510203	6220800	[illegible]
1520	0.000206847	0.97015709	6931200	[illegible]
1600	0.000127788	0.983360901	7679999.9	[illegible]
1680	7.38712E-05	0.991275604	8467199.9	[illegible]
1760	3.98539E-05	0.995711319	9292800	[illegible]
1840	2.00133E-05	0.998029571	10156799.9	[illegible]
1920	9.32902E-06	0.999156447	11059200	[illegible]
2000	4.02555E-06	0.999664537	11999999.9	0.000335463









Instructions: To view the Weibull distribution for any time period, enter the Characteristic Life (Alpha) in Cell C90 and the Shape parameter (Beta) in Cell C91. If there is a time delay (gamma) enter in Cell C92. Then enter the time period of interest. For example, between 6 and 12 months, enter 4380 for plot star time in Cell C93 and 8760 in Cell C94 for plot end time. The PDF, CDF, Hazard Rate (Instantaneous Failure Rate) and Reliability values are given at the time over the plot

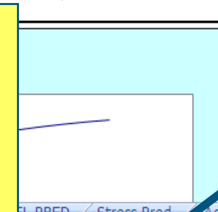
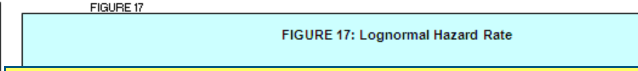


FIGURE 17

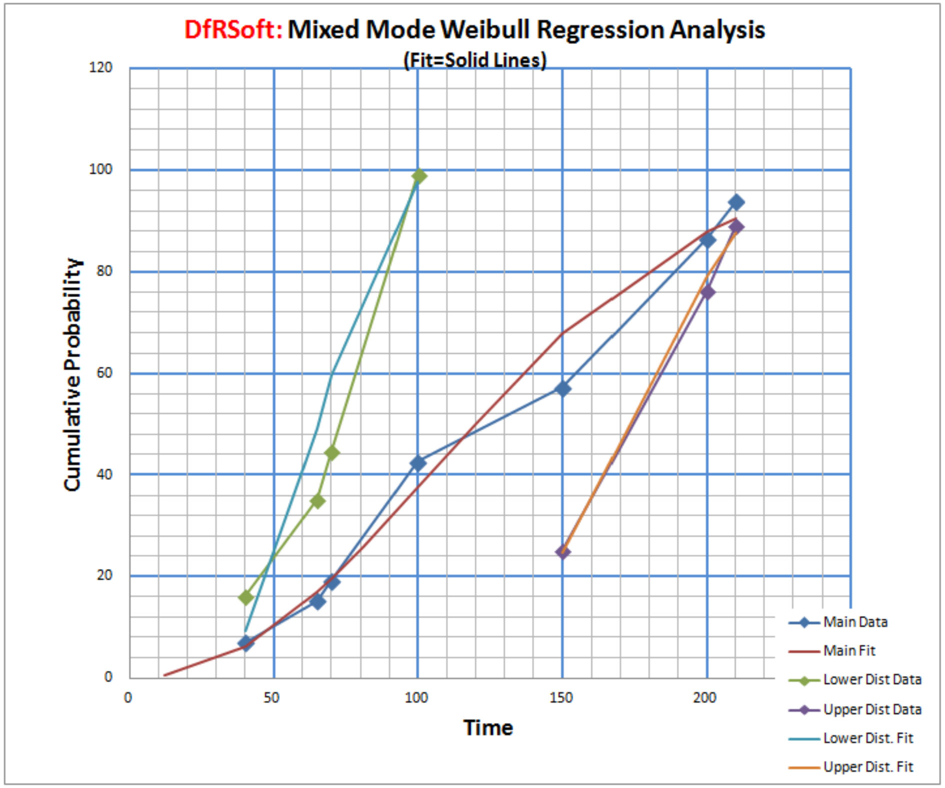


Software provides capability to look at the any common distribution. For given parameters. For example if you find the beta and characteristic Life, from reliability plotting then you can enter these here and look at the PDF, CDF, Hazard rate, and reliability over any time period.

Found on “Rel Plot” Work Sheet

Mixed Modes: Capability to separate out as many modes as can be observed

Bimodal Analysis with Option to Iterative Modal Analysis



Bimodal Results with Inflection Point at 43%

Weibull Bimodal Regression Results				
Uppper Distribution (From 43% to 100%) Results				
Beta 1	Char Life 1 (63.2% failure)	MTBF 1 Expectation	Intercept 1 (not gamma)	Statistical Rho 1
5.93303	185.4309608	171.920827	5.22268263	0.995162
Lower Distribution (From 0 to 43%) Results				
Beta 2	Char Life 2 (63.2% failure)	MTBF 2 Expectation	Intercept 2 (not gamma)	Statistical Rho 2
3.97207	71.69381364	64.9575911	4.27240446	0.957

This Analysis Can be Extended to all Distribution Including MLE and Weibull.
As Well the User can Extend this Bimodal Analysis to Multiple Modal Analysis.
Please review the Instructions & Video below to learn how.

Mixed Mode Video Instruction

Mixed Mode Help

Hyperlink Back To Analysis Area

Video Inst.,

Pop-Up Inst.,

Distribution & Confidence Page Full Analysis of Any Key Distribution

	A	B	C	D	E	F	G	H	I	J
48										
49	Example: 100 devices are tested and 1 failure is observed, what is ths upper and lower Chi-square and Standard Limits 90% confidence bounds for the failure %? Enter 1 in Cell B44, 90 in Cell B45, 2 for 2 sided estimate									
50	in Cell B46, and 100 in cell B47. Read the upper and lower bounds in Cells E44 & G44 and D44&F44 (i.e. Chi Square is 4.74% and 0.0513%). Note these bounds are about the 1% (1 fail of 100) failure point estimate cell C44.									
51										
52		VEIBULL FAILURE RATE ANALYSIS								
53		ENTER		RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	MTTF
54	QUANTITY TO			Fraction Failing	Estimate			HAZARD	CUM	
55	ENTER	QUANTITY		CDF	Characteristic	Beta	Reliability	FAIL RATE	FAIL RATE	
56		VALUE	NOTES	at 672 HRs	Life			At Time Entered	At Time Entered	
57	Analysis For finding F		Characteristic					125.46360	86.97174	
58	Characteristic Life	5.00E+03	Life is Similar To	0.058445011	5,000.00000		0.941555	Per 10^6 hours	Per 10^6 hours	3848.344
59	Beta	1.4	MTBF, it represents	5.844501%		1.40000		125,463.598262392	86971.743	
60	Time t of Frac Failure	672	time to 63.2% Failure					Above in FITs	Above in FITs	
61	Analysis For Char. Life							11.53	11.20000	
62	Frac Fail (enter 0<F<1)	0.056	Beta values:	0.06			0.944000	Per 10^6 Hours	Per 10^6 Hours	60138.63015
63	Time t to Frac Fail	5000	B=1 is exp dist.	5.600000%	86762			11,525.82	11,200.00	
64	Beta	1	B<1 Infant Mort.			1.000E+00		Above in FITs	Above in FITs	
65	Beta Analysis		B>1 is wear-out					5.31	6.3927	
66	Frac Fail (enter 0<F<1)	0.056						s	Per 10^6 Hours	190557.344
67	Time to Frac Fail	8760	Keep time unit same						6,392.69	
68	Charc Life	300000	as Char Life					s	Above in FITs	

69 Weibull Temperature Hyperlink

70 Example: If the Weibull characteristic life is 400,00 hours and B... is 2.5, what is the c...

71 in Cell B60. Read 0.0222 in Cell D58 or 2.2% in Cell ... Note the reliability is 0.9778 ... art of bathtub curve, 1< Beta < 4 mild wearout l...

72

73 Veibull Confidence

	A	B	C	D	E	F	G	H	I	J	K
74	ENTER	ENTER	ENTER					er	1-Sided Lower	1 Sided	1 Si
75	Number	Prediction	Characteristic	Beta	Confidence	Bound	Bound	Bound Failure	Bound Failure	Upper	Low
76	Tested	Time	Life (Eta)		%	Reliability	Reliability	Rate in FITs	Rate in FITs	Time	Ti
77	254	750	883	4.11	90	5.5602E-01	6.4066E-01	3.2165E+06	2.4400E+06	7.8407E+02	7.174
78	17	16	8.8	4.11	90	1.1568E-15	1.9054E-02	8.8347E+09	1.0173E+09	2.2649E+01	1.130
79											

80 Use this predictor to estimate the upper and lower bounds on the failure rate and reliability. Example: 25 Samples are accelerated life tested, Prediction at use are Eta 100,000, Beta 184.

81 Determine the 1-sided 90% confidence bounds on R and the failure rate at 10,000 hours. Enter 25 Cell A77, 10,000 cel B77, 100000 in cell C77, 1.84 in cell D77, and 90 in cell E77.

82 Read 1-sided results 0.9352 < R < 0.99688 cells F and G77. and 574 FITs < Failure Rate < 12.323 FITs Cells H and I 77.

INDEX & Lic Ag. | HINTS | Conversions | Cpk | Acceleration Factors | Test Plan | **Dist & Conf.** | Rel Plts | S-Rel Plts | System Reliability

All the common distributions & Confidences can be found for any parameter at any time. Here is a Weibull analysis.

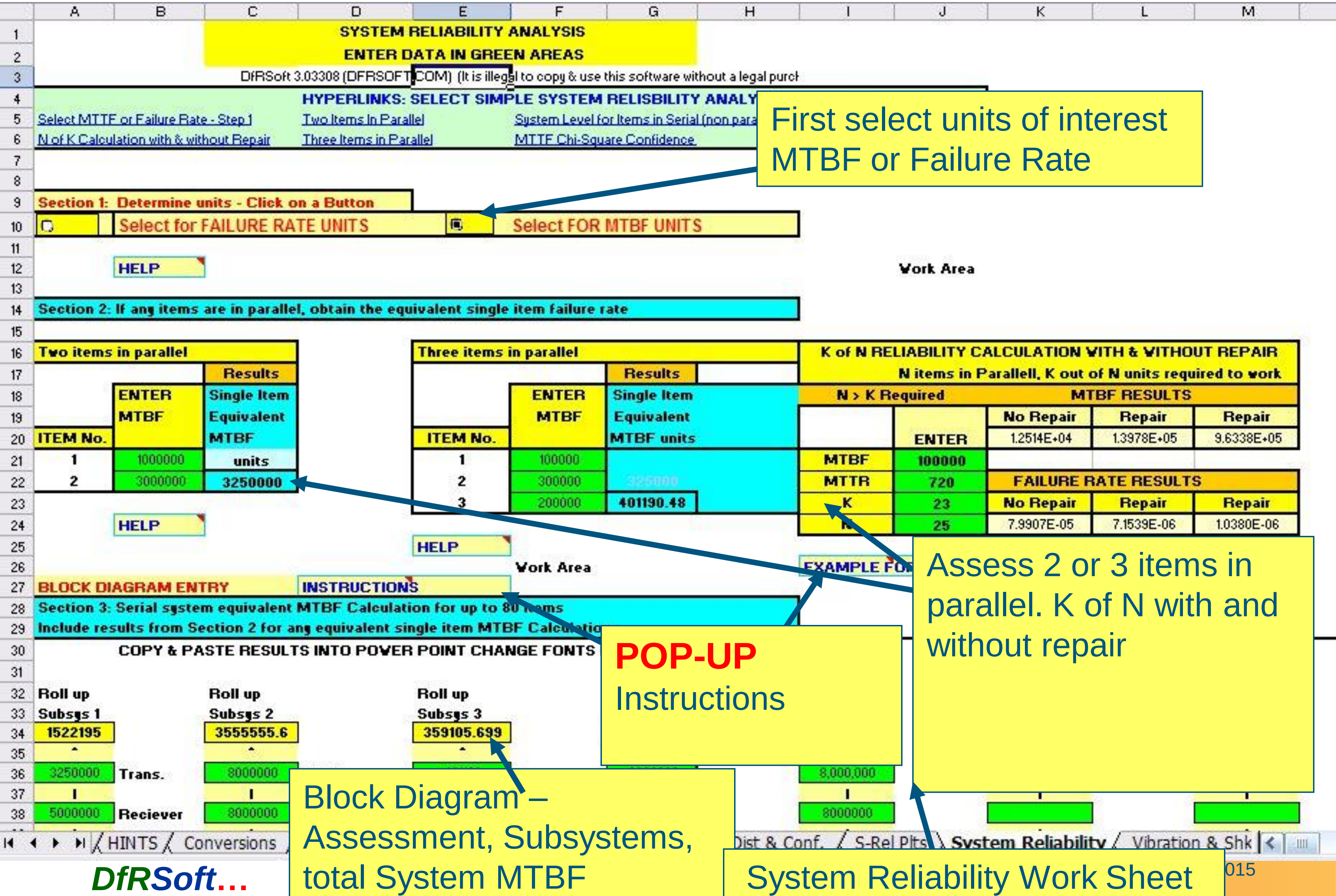
Distributions & Confidence Page

Benchmark Information on Reliability Plotting in DfRSoft

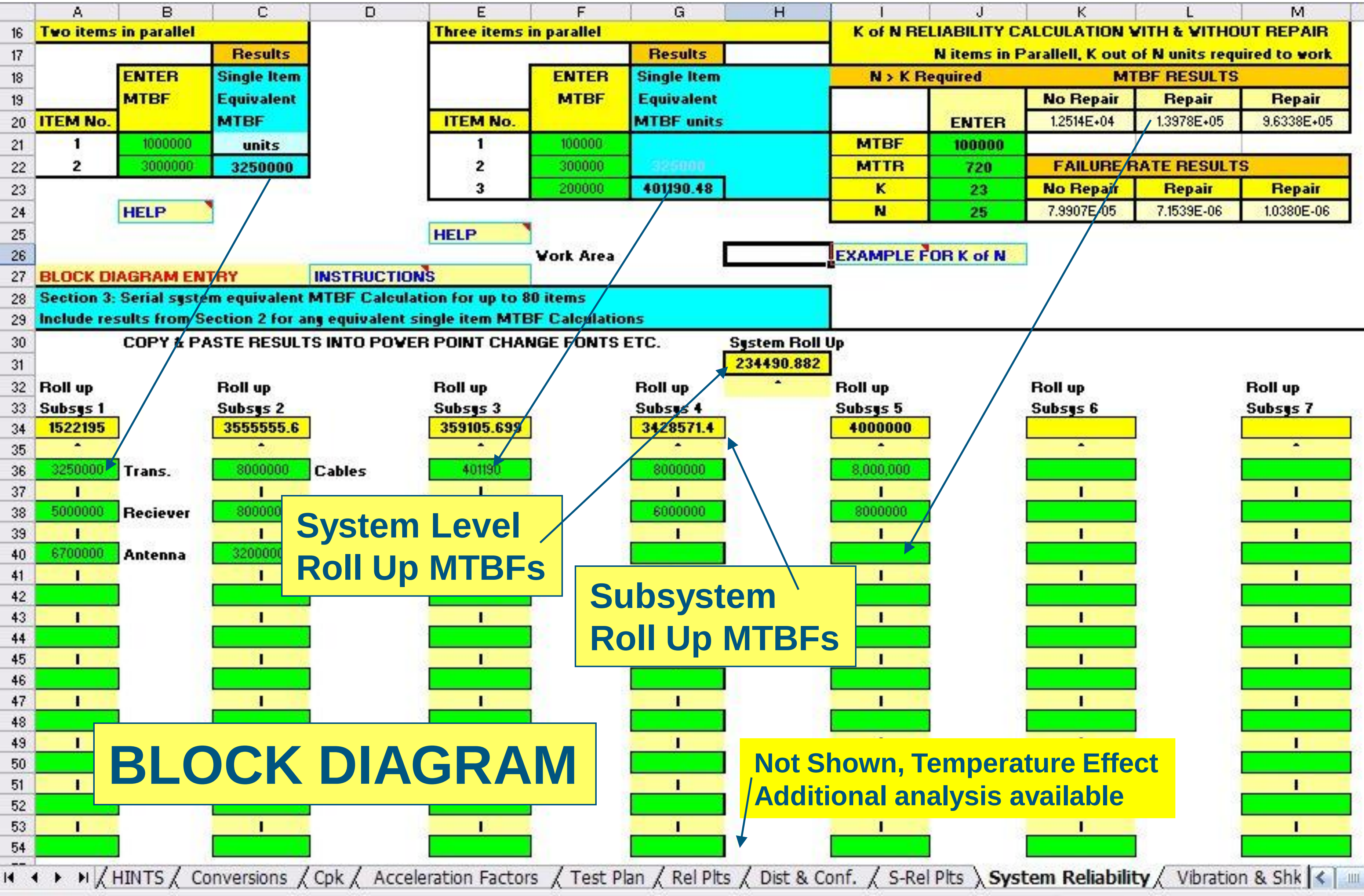
- DfRSoft Reliability Plotting tool has been benchmarked with other industry standards like Weibull++. DfRSoft results are statistically identical in plotting position and distribution results.

- DfRSoft has <u>superior graphic options </u>(same as Excel)
- Our analysis methods are more complete with multiple tools
- Ease to replot any distribution over any time period
- Excellent Confidence analysis and Best Predictors
- Mixed Mode Analysis
- Weibull-Bayesian: "WeiBayes" analysis

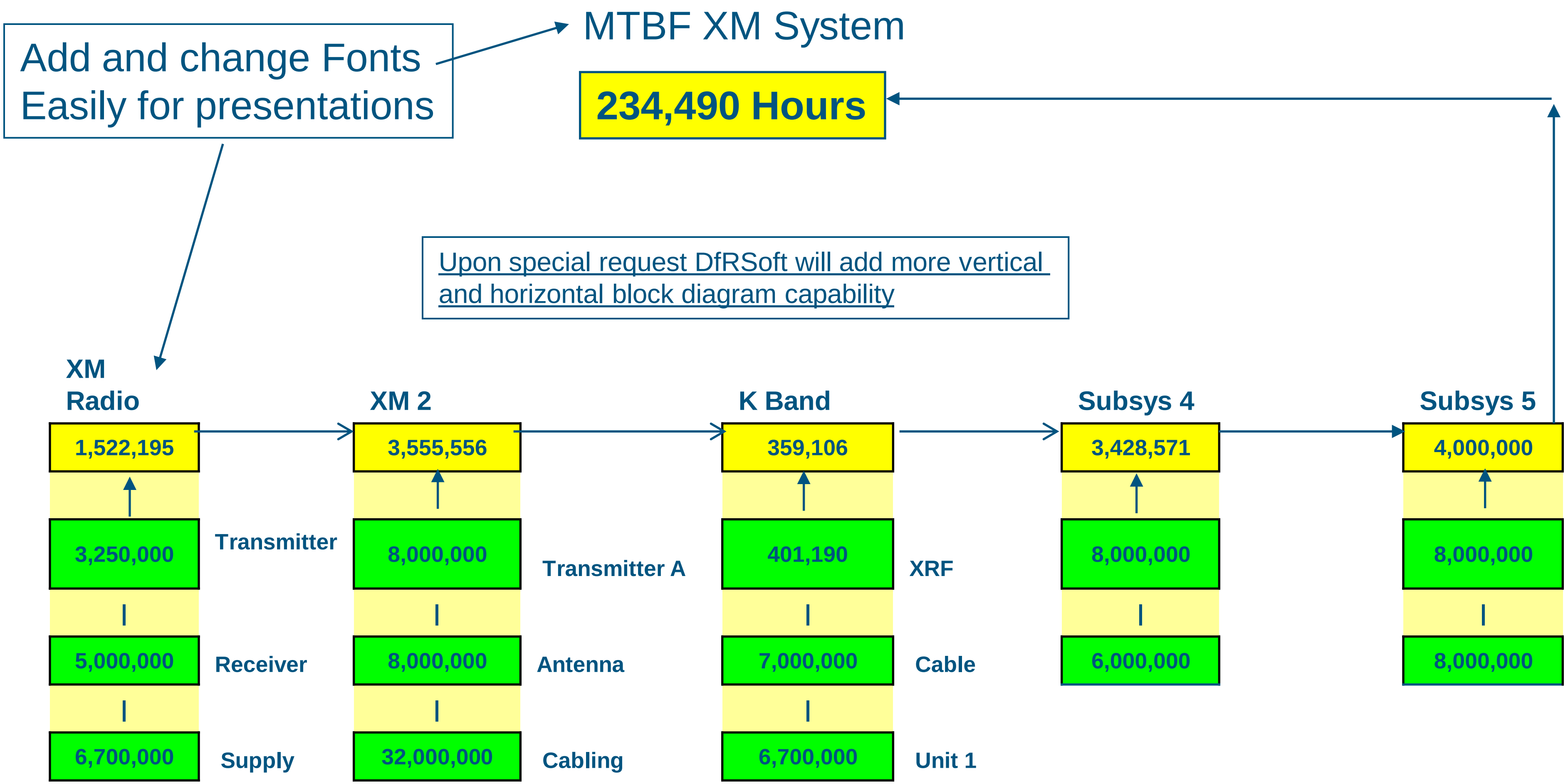
System Reliability



Block Diagram Sub & System Level Analysis



Cut & Paste Block Diagram Results into Power Point for Presentations & Reports



System Reliability – Redundancy Analysis

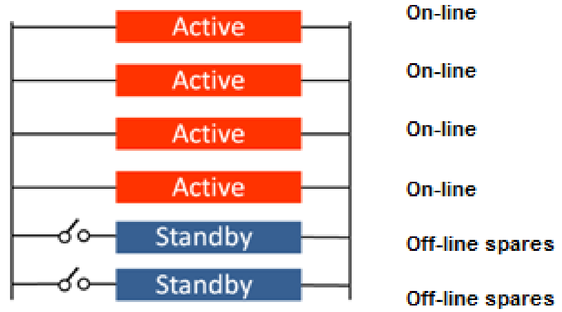
TWO ACTIVE ON-LINE UNITS WITH DIFFERENT FAILURE RATES AND REPAIR RATES. (One of two required for success)

		MTBF RESULTS	
		No Repair	RADC Repair
	ENTER	2.333333333	0.522222222
MTBF A	1		
MTBF B	2	FAILURE RATE RESULTS (in FITs)	
MTTR A	5	No Repair	Repair
MTTR B	10	4.29E+08	1.91E+09

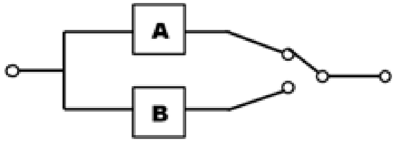
Comment Model

Active & Standby Block Diagram

K – Parallel Active, N Total



N-K Standbys with Switch



1 STANDBY OFF-LINE WITH K ACTIVE ON-LINE UNITS REQUIRED FOR SUCCESS (Active units equal FR, non active standby units 0

		MTBF RESULTS -1 STANDBY	
		No Repair	RADC Repair
	ENTER	2266.5573	1177.777778
MTBF	100	FAILURE RATE RESULTS (in FITs)	
MTTR	1	No Repair	RADC Repair
K	3	441197.7585	849056.6038
Switching Prob.	1	RELIABILITY	
Time (Optional)	1	0.9995589	0.999151304

Comment Model

STANDBYS (Non Active) & ACTIVE UNITS (All Same FR) (non active standby units 0 FR while on standby)

		RESULTS
		1 STANDBYS - No Repair
	ENTER	Reliability
MTBF	100000	0.982476904
N (Total Units)	3	Cumulative FR (in FITs)
K (Total Active)	2	1767.844321
Switching Over Prob.	1	MTBF (1/ Cum FR)
Switch Op. Fails Open Prob	1	565660.6684
Mission Time	10000	

Comment Model

ONE ACTIVE UNIT "A" & ONE STANDBY "B"

		RESULTS
	ENTER	
Reliability of A	0.9	Reliability
Reliability of B	0.96	0.98832
Switching Over Prob.	0.92	MTBF
Switch Op. Fails Open Prob	1	851154.593
Mission Time (Optional)	10000	

Example

Chi-Square Test Planning

CHI SQUARE SAMPLE SIZE CONFIDENCE TEST PLANNING

DfRSoft Trial Version 3.0320 (DFRSOFT.C

HYPERLINK INDEX:

Chi Sq Life Test Time Estimate	Chi Sq FR Device Hrs	Handy Schedule Planning Tool
Chi Sq Test Time Planning	Multiple Chi-Square Failure Rate Test Planning	Multiple Chi-Sq Failure Rate Plan Pl
Chi Sq Sample Planning	Sample Optimization For a 3 Test Failure Rate	Test Planning Summary
Chi Sq Failure Rate Plan		Estimate Device Hours, FITs, MTB

HTOL Life Test Calculator

Section 1: Single Test Sample Size Chi-Square Test Planning

Chi Square Life Test Time Estimate		
Value	Enter	Results
MTBF target	35000	Test Time
Num Test Units	5	Results
Num Failures Allowed	1	1810.36807
Confidence Level	80%	in Hours
Duty Cycle	100%	
Use Temp (C)	25	Accel Factor
Test Temp Stress ®	45	11.55188882
Act Eng (eV)	1	

TEST TIME PLANNING		
QUANTITY	ENTER QUANTITY VALUE	RESULTS TEST TIME
N (Samp Sz)	2	13745.73571
FITs	6666	
AF (Acc Fac)	5	Dev. Hrs
Conf %	60	137457.3571
No. Failures	0	

SAMPLE PLANNING		
QUANTITY	ENTER QUANTITY VALUE	RESULTS N Sample Size
Test Time	13745	2.000107051
FITs	6666	
AF (Acc Fac)	5	Dev. Hrs
Conf %	60	137457.3571
No. Failures	0	

QUAI
Test T
Sampe
AF (A
Conf %
No. Fa

Example: How many samples are needed for a 1000 hour accelerated test having an acceleration factor of 62.5, in which we wish to demonstrate that the failure rate is no worse than 500 FITs with 1 Failure observed during testing. at the 90% confidence level? Since we are looking for a sample size, we enter values in cells J15-J19. For one failure, Enter 1 in Cell J19, Enter 90 for 90% confidence in J18. Enter the AF of 62.5 in Cell J17 and 500 in Cell J16. Finally enter the test time of 1000 in Cell J15. The results requires 124 samples shown in Cell K15. Note testing yields 7.7 million device hrs cell K18.

Section 2: Multiple Chi-Square Failure Rate Test Planning

MULTIPLE TEST INPUTS - USE FOR FIT ALLOCATION OR SAMPLE SIZE OPTIMIZATION BELOW

Test	Test Duration	Use Conditions	Stress Condition	1st Key Param	2nd Key Param	AF	Accel Hours	Accel Years
Temp Cyc	100	25	95	1.9	NA	12.6353953	3.0325E+04	3.461752138
THB RH		40	85	NA	2.66	7.42633892		
THB Temp	1000	25	85	0.7	NA	713.0383983	7.1304E+05	81.39707744
HTOL	1000	50	150	0.7		0.2312477	3.8023E+05	43.40539357
Vib	3	0.005	0.04	4		4096	1.2288E+04	1.402739726

0.7 eV is industry standard

START
FINISH
START
MEAS
TEST I
FINISH

INDEX & Lic Ag. / HINTS / Conversions / Cpk / Acceleration Factors / Test Plan / Dist & Conf. / Rel Plts / S-Rel Plts / System Reliability

Cell G32 commented by MA040442

Test Plan Work Sheet

Chi-Square Multi-Test Planning

First enter accelerated Test values

MULTIPLE TEST INPUTS - USE FOR FIT ALLOCATION OR SAMPLE SIZE OPTIMIZATION BELOW								
Test	Test Duration	Use Conditions	Stress Condition	1st Key Param	2nd Key Param	AF	Accel Hours	Accel Years
Temp Cyc	100	25	95	1.9	NA	12.6353953	3.0325E+04	3.461752138
THB RH		40	85	NA	2.66	7.42633892		
THB Temp	1000	25	85	0.7	NA	713.0383983	7.1304E+05	81.39707744
HTOL	1000	50	150	0.7	NA	380.2312477	3.8023E+05	43.40539357
Vib	3	0.005	0.04	4	NA	4096	1.2288E+04	1.402739726

ENTER	STAT
	Confidence %
Chi-Square Conf.	90

Enter Confidence level

TESTING FIT ALLOCATION RESULTS								
	ENTER	ENTER	SIZE FOR EACH TEST					
Test	Sample Size	Num. Failures	DUTY CYCLE Percent	FITs 90% Conf. Per Test				Total FITs All Tests 90% Conf.
Temp Cy Test 1	39	1	100	3288.922778	0.913187484	(304051)	1.182[illegible]E+06	
THB Test 2	24	0	100	134.5524249	0.03735922	848.4072377 (7432047)	1.7113E+07	3601.585475
HTOL Test 3	34	0	100			640.924579		
Vibration (Not Totaled)	3	0	100					
TOTALS*	97	1						
Not Including Vibraion								

The above table estimates the Chi Square test estimates based on the test parameters, sample sizes, and confidences entered

TEST PLANNING SUMMARY

Test Result Area Total FITs

Enter Sample sizes & number of failures allowed

Test Plan	ENTER
Total Test FITs	400
Chi-Sq Conf.%	90

SAMPLE SIZE OPTIMZATI		
	Optimal	EN
Test	Number Allowed Failures	Opt Samp 400
Temp Cy Test 1	0	58.27
THB Test 2		

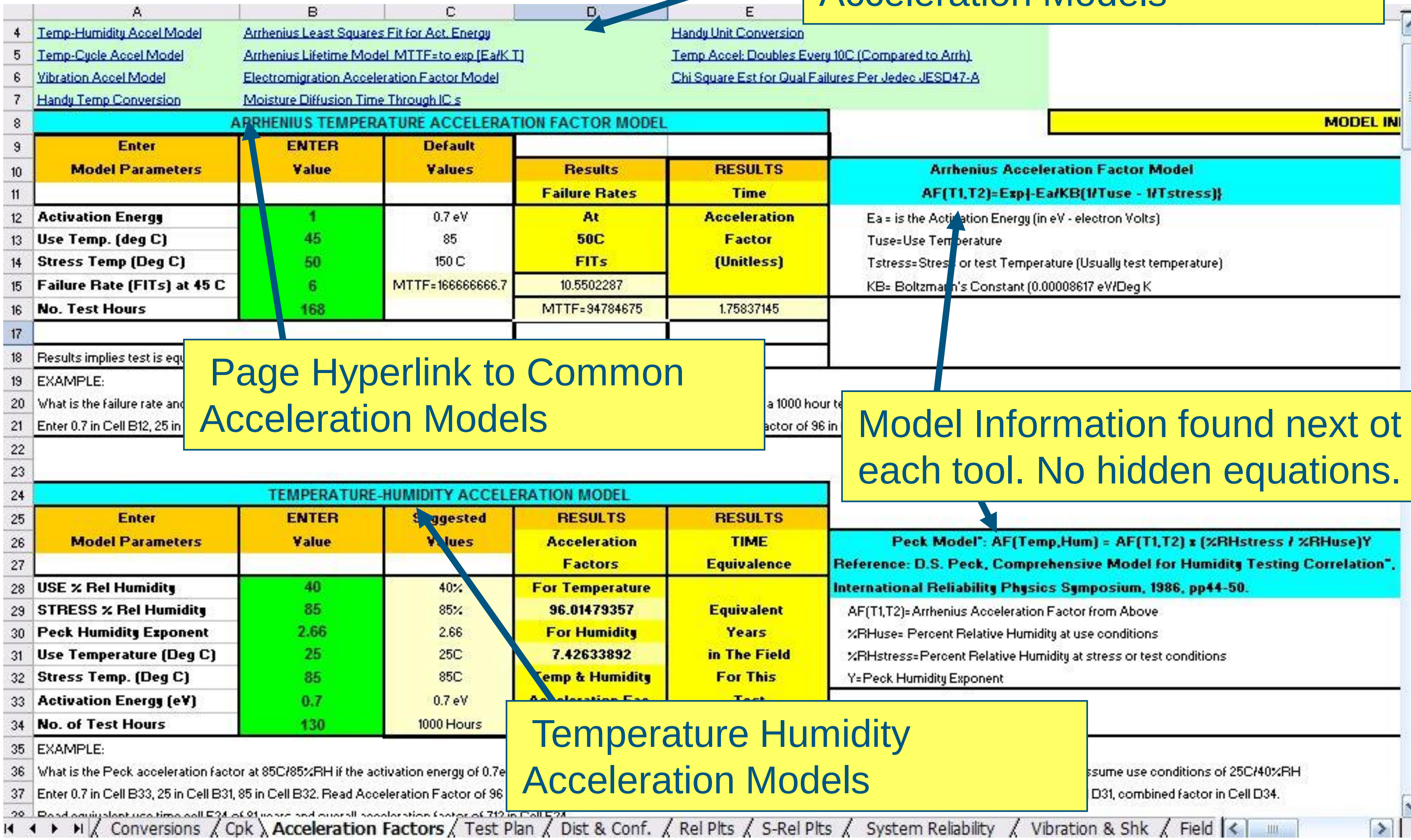
START
FINISH
START
MEAS
TEST I
FINISH

Sample Optimization can also be used just by test confidence and total FITs allowed, and failures, optimization routine calculates optimal sample size

INDEX & Lic Ag. / HINTS / Conversions / Cpk / Acceleration Factors / Test Plan / Dist & Conf. / Rel Plts / S-Rel Plts /

Test Plan Work Sheet

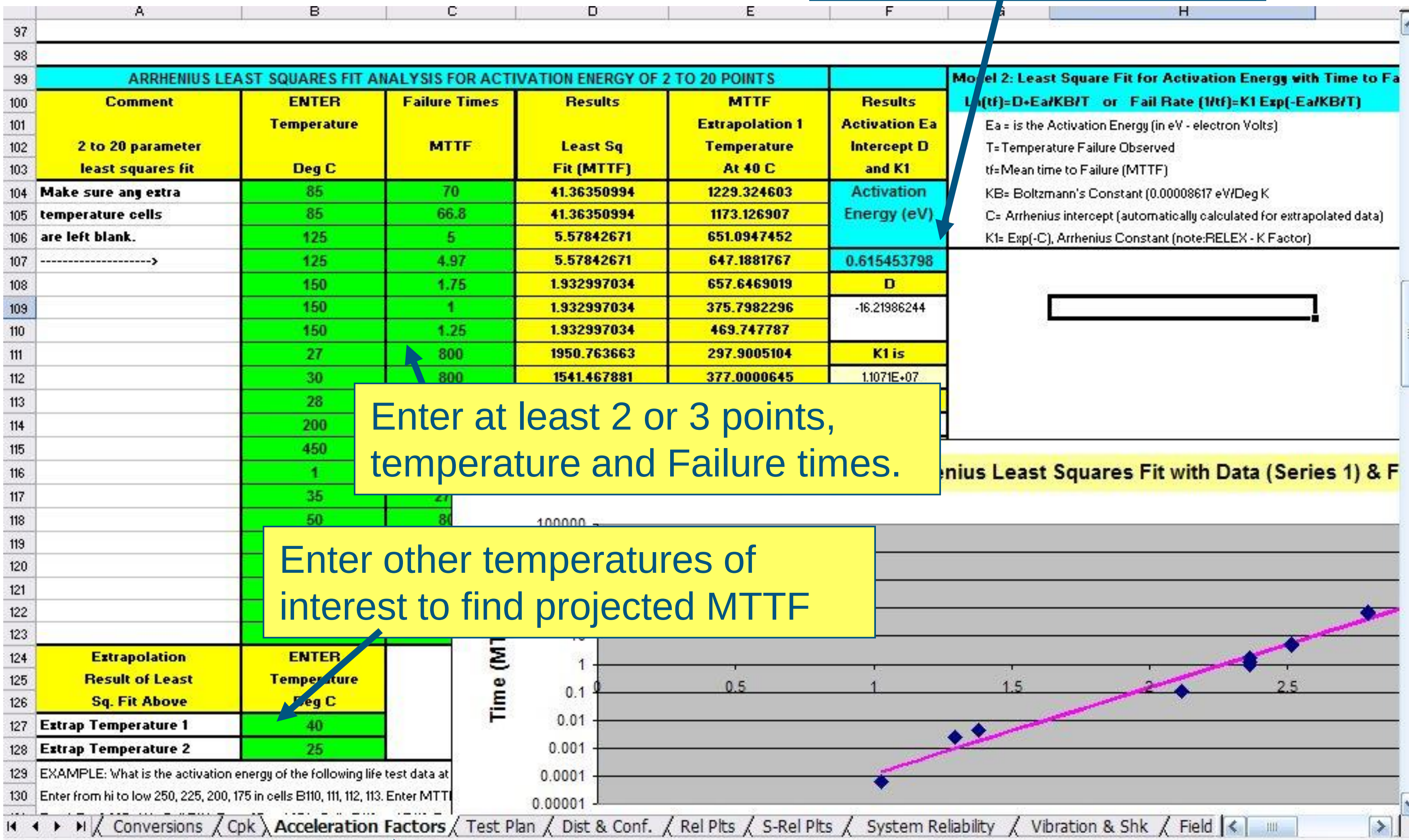
Acceleration Factor Tools



Acceleration Factor Page

Arrhenius Plotting

Activation Energy and model values



Enter at least 2 or 3 points, temperature and Failure times.

Enter other temperatures of interest to find projected MTTF

Acceleration Factor Page

Reliability Growth – Multi-Test Capability

(Assess your products growth as you find and fix failure modes)

Handy Table to Obtain Acceleration Factors Quickly For Reliability Growth

Test	Test Duration	Use Conditions	Stress Condition	1st Key Param	2nd Key Param	Acceleration Factor	Accel Hours	Accel Years
Temp Cyc	200	20	205	2.5	NA	336.3641201	1.6145E+06	184.3091069
THB RH		40	85	NA	2.66	7.42633892		
THB Temp	1000	25	85	0.7	NA	713.0383983	7.1304E+05	81.39707744
HTOL	1000	85	115	0.7	NA	5.772282425	5.7723E+03	0.65893635
Vib	3	0.005	0.04	4	NA	4096	1.2288E+04	1.402739726

Handy Multi Test Acceleration factor tool provided to find acceleration factor.

FIGURE 2

Accelerated Reliability Growth Test Analysis Section

Enter Test Type (Optional)	Enter number of Test Failures" (not Cum	Enter Failure e (not Cum T	Enter Total Samples Per Test	Enter Test Acceleration Factor
High Temperature Life	1	25	33	6
	1	300	33	6
Temperature Cycle	1	48	20	336
Vibration	1	3	20	4000
	1	3	20	4000
Humidity	1	90	20	713
	1	500	20	713
				1
				1
				1
				1
				1
				1
				1
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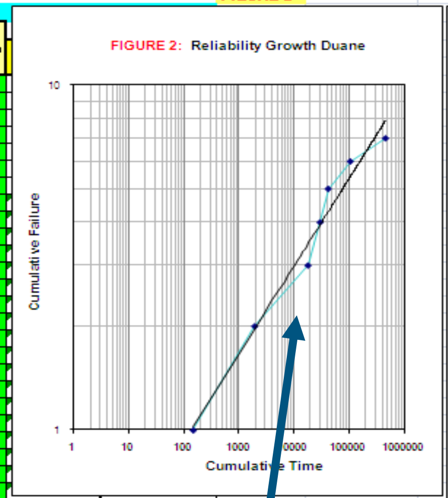
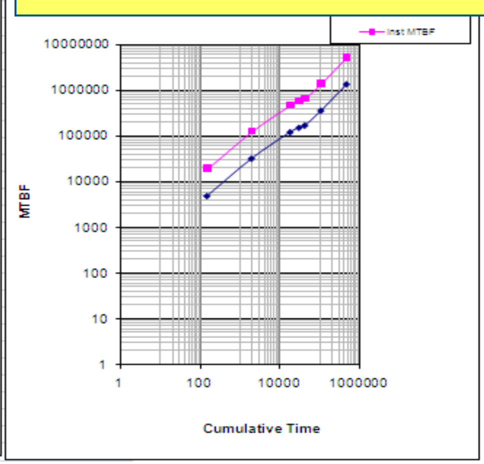
				1
				1
				1
				1





Multi Test Example of High Temp, Temp cycle, humidity. For each test enter num of failures, Approx test time of failure or end of test time, Total samples tested, and test acceleration factor.

INSRUCTIONS

MTBF Growth and Duane plots

UNPROTECTED WOR

Growth Model Results	
Beta	0.254169079
Growth Alpha=1-Beta	0.745830921
Test Cum Device Hrs.	[illegible]280310
Crow-Amsaa	
Fail Rate initial (Lambda 1)	0.00020202
Initial Time T1	150
MTBF Initial M1	4950
Last Cum Time	462748
Duane	
Failure Rate (Lambda i)	0.286517625
Estimate Final Growth Statistics	Enter Final Growth
Enter Last Cum Time	462748

Rel Growth alpha, beta obtained on test

	Cumulative Failures	Cum MTBF	Cum Fail Rate	Inst Fail Rate	Inst MTBF	Reliability (instant FR)	Reliability (Cum Failure Rate)
Cr/AMSAA	0.233531977	1981518.785	5.04663E-07	1.2827E-07	7796065.48	0.942370653	0.791732278
Duane	7.89054045	58645.91949	1.70515E-05	4.33396E-06	230735.8537	0.134588756	

Field Returns / System Reliability / Dist & Conf. / 217PRED / TEL PRED / Stress Pred / Acceleration Factors / Test Plan / **Rel Growth** / D-FMEA / Avail & Spares / TS

Reliability Growth Page

Chi Sq Reliability Growth – Multi-Test Assessment

Using Chi-Square Method Instead of Duane. DfRSoft is the inventor of this method. It is easier to use than Crowe/AMSAA has multi-test advantages – more practical!

need to convert cycles to field hours. For example 1 cycle typically equals 24 hours in the field. Thus 10 cycles enter 240 hours for the test time. If you have a test like drop shock, you can estimate an acceleration factor. For example, you might acceleration factor. Enter the Chi-square confidence in percent in cell B178 (i.e. 90 for 90%). Reliability growth occurs when you fix failure modes. For each failure, estimate the fix effectiveness of your fix. For example, if you are certain you fixed problems. In column I you can enter optional information about the fix description. Reliability growth results are provided in Graphs and in the tables. Tabular results are in columns J through R. With plot summary in columns T-AB. Reliability gr provided below and far to the right for each test and graphs for "All Test Reliability Growth Summary"

All Tests Reliability Growth Summary and Metric

		Alpha=1-Beta	0.103825503
		Beta	0.896174497
Total Hours	MTTF	Ln(Cum Time)	Ln(MTTF)
1	52469.23646	0	10.8679823
872	105975.4691	6.77078942	11.57096292

Humidity Test Test Summary

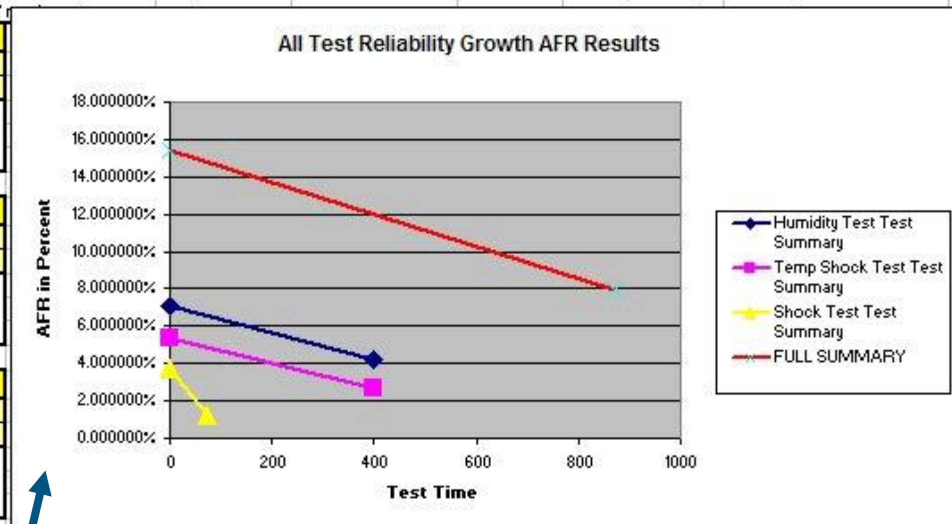
		Alpha=1-Beta	0.089444618
		Beta	0.910555382
Total Hours	MTTF	Ln(Cum Time)	Ln(MTTF)
1	118839.1453	0	11.68552614
384	202355.0462	5.95064255	12.21777909

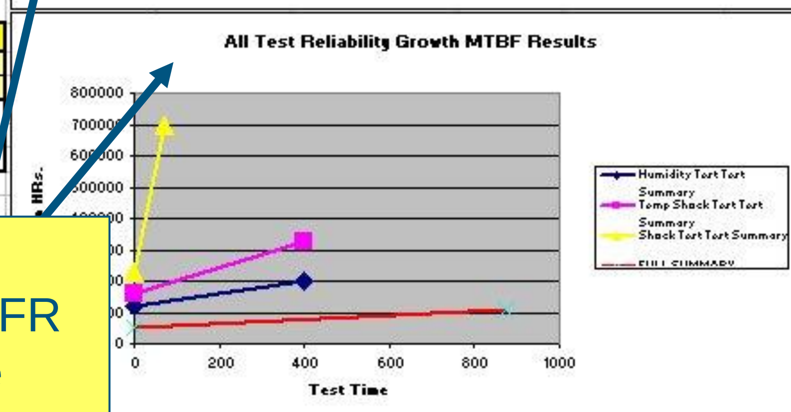
Temp Shock Test Test Summary

		Alpha=1-Beta	0.120221474
		Beta	0.879778526
Total Hours	MTTF	Ln(Cum Time)	Ln(MTTF)
1	159247.6054	0	11.97821554
400	327262.6164	5.99146455	12.69851824

Shock Test Test Summary

		Alpha=1-Beta	0.259496007
		Beta	0.740503993
Total Hours	MTTF	Ln(Cum Time)	Ln(MTTF)
1	229120.1659	0	12.34200189
72	695078.2234	4.27666612	13.45177967

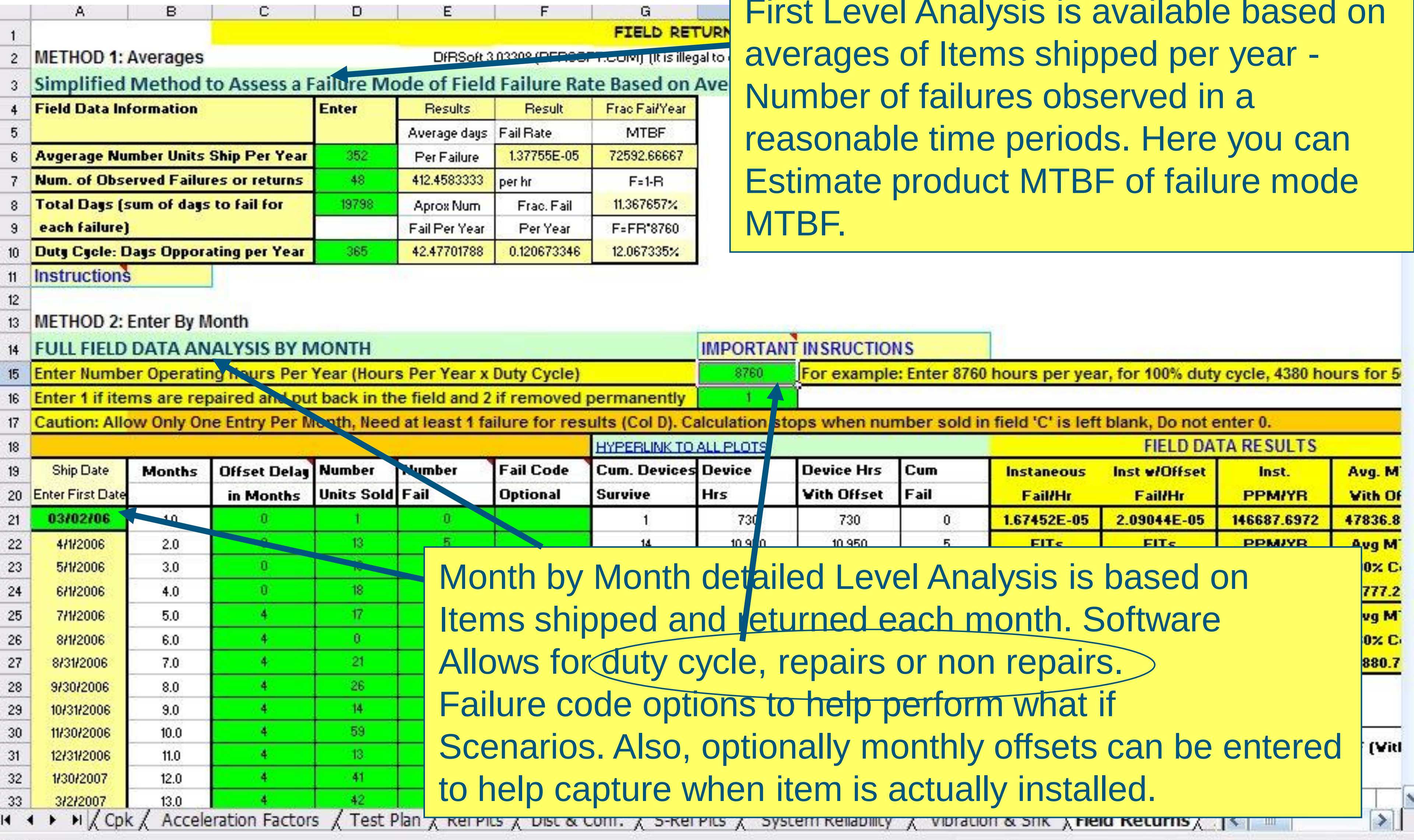




Using Chi Sq. Methods to find Reliability Growth MTBF and AFR valuse for each test and for the product as well as growth alphas and betas

Field Returns is convenient and simple to use with two methods available

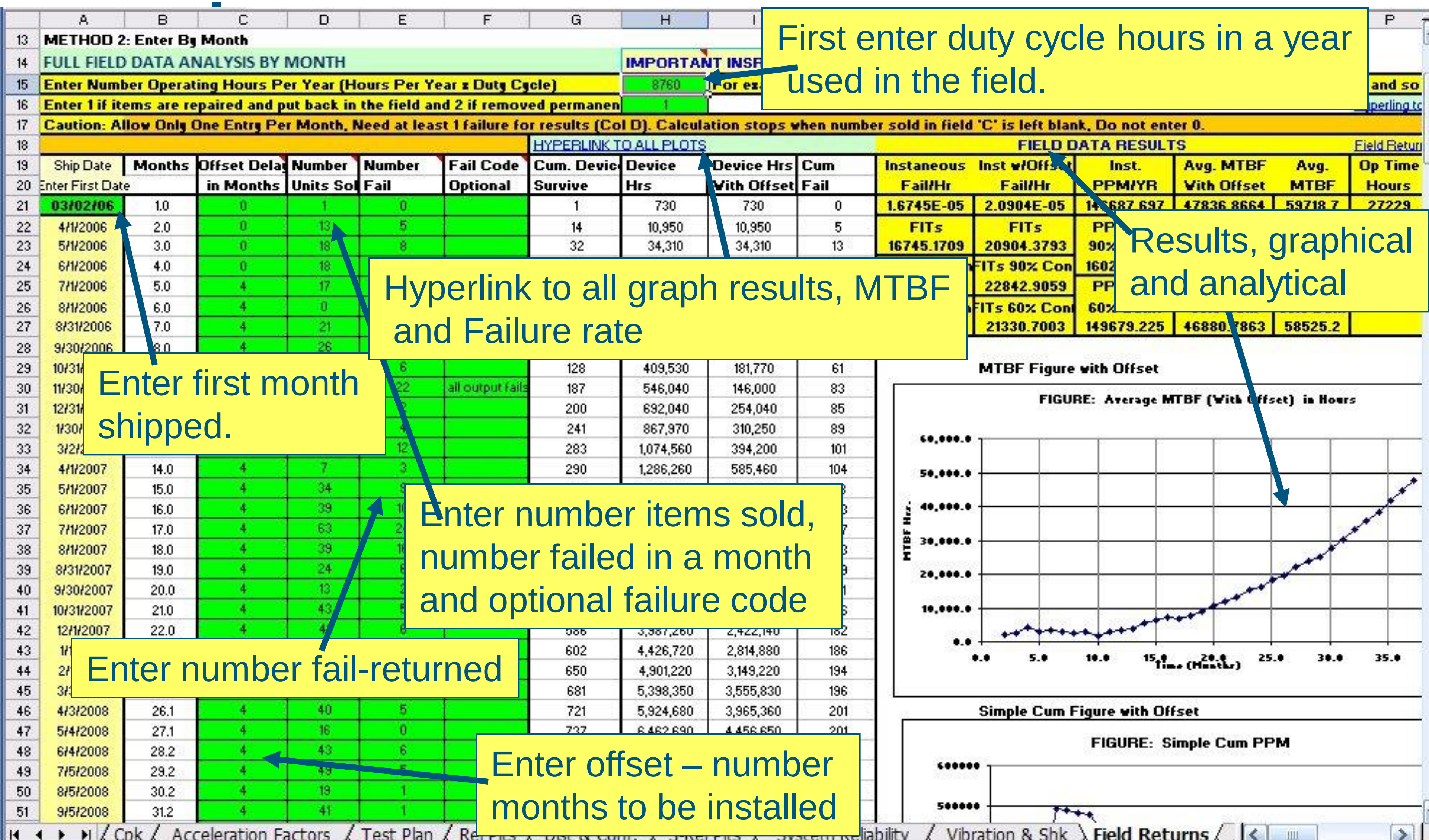
First Level Analysis is available based on averages of Items shipped per year - Number of failures observed in a reasonable time periods. Here you can Estimate product MTBF of failure mode MTBF.



Month by Month detailed Level Analysis is based on Items shipped and returned each month. Software Allows for duty cycle, repairs or non repairs. Failure code options to help perform what if Scenarios. Also, optionally monthly offsets can be entered to help capture when item is actually installed.

DfRSoft…

Field Returns Analysis – simple entry form with many options – graphical



MIL HDBK 217 Detailed Stress Parts Count & Telcordica

Enter activation code after purchase to see base Failure Rates

PARTS COUNT MTBF PREDICTION BY MIL-HDBK-217F(1)

DfRSoft 2012.7 - www.DFRSoft.com

Enter Base FR Activati 222

Results of Prediction

MTBF IN HOURS
3002102
ASSEMBLY TOTAL FR IN FITs
333.1
ASSEMBLY TOTAL FR/10^6 Hrs.
0.3331

Assembly Name: New Engine
Assembly Number: M-380
Assembly Rev: 2
Manufacturer and System: NG

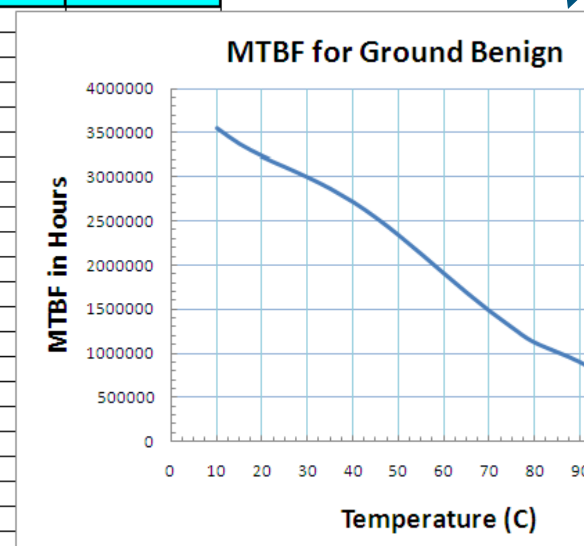
Analysis Date: 1/5/2012
Analyst: John Smith

AN ACTIVATION CODE MUST BE ENTERED INTO CELL M4 IN ORDER FOR THE BASE FR TO BE POPULATED - SUPPLIED UPON PURCHASE OF DFRSOFT

Ground Benign (GB) Q=1, Ambient is 30C, Assumes 50% Stress

List Number	Part Type	Complexity	Base FR (FR/10^6 Hrs.)	Qty Used	Q Factor	Total FR (Fail/10^6 Hrs.)	Notes	FR Basis
1	IC,Bipolar,Logic,Plastic	1-100 Gates	0.0036	1	1	0.0036		
2	IC,Bipolar,Logic,Plastic	>100-1K	0.006	2	1	0.012		
3	IC,Bipolar,Logic,Plastic	>1K-3K	0.011	2	1	0.022		
4	IC,Bipolar,Logic,Plastic	>3K-10K	0.033	3	1	0.099		
5	IC,Bipolar,Logic,Plastic	>10K-30K	0.052	2	1	0.104		
6	IC,Bipolar,Logic,Plastic	>30K-60K	0.075	0	1	0		
7	IC,Bipolar,Gate Array&Linear,Plastic	1-100 Trans	0.0095	1	1	0.0095		
8	IC,Bipolar,Gate Array&Linear,Plastic				1	0.017		
9	IC,Bipolar,Gate Array&Linear,Plastic				1	0.066		
10	IC,Bipolar,Gate Array&Linear,Plastic				1	0		
11	IC,Bipolar,PLA/PAL,Plastic				1	0		
12	IC,Bipolar,PLA/PAL,Plastic				1	0		
13	IC,Bipolar,PLA/PAL,Plastic				1	0		
14	IC,Bipolar,uP,Plastic				1	0		
15	IC,Bipolar,uP,Plastic				1	0		
16	IC,Bipolar,uP,Plastic				1	0		
17	IC,Bipolar,ROM&PROM,Plastic				1	0		
18	IC,Bipolar,ROM&PROM,Plastic	>16K-64K	0.017	0	1	0		
19	IC,Bipolar,ROM&PROM,Plastic	>64K-256K	0.028	0	1	0		
20	IC,Bipolar,ROM&PROM,Plastic	>256K-1M	0.053	0	1	0		
21	IC,Bipolar,SRAM,Plastic	16K Bits	0.0075	0	1	0		
22	IC,Bipolar,SRAM,Plastic	>16K-64K	0.012	0	1	0		
23	IC,Bipolar,SRAM,Plastic	>64K-256K	0.018	0	1	0		217F-1 Part Count
24	IC,Bipolar,SRAM,Plastic	>256K-1M	0.033	0	1	0		217F-1 Part Count

Enter Quantity Used and Pi Q Factor



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217PRED PAGE

DfR MISC Tools – Numerous tools to assess needed physical situations. Dielectric breakdown example below.

Notes: * leave blank or 0 to use default

** Typically results not valid below 5 microns

Breakdown varies with pressure, For other pressures use Paschen's law below.

PASCHEN LAW - Voltage Breakdown in Air at Any Pressure

Enter	Enter	Breakdown Voltage
Distance in Meters	1.00E+00	Volts/Meter
Pressure in Atmospheres	8.10E-01	2805244.056

BREAKDOWN IN A SOLID DIELECTRIC

Distance Units	Distance Input 1	Enter Breakdown Input 2 in MV/cm	Breakdow[n] Results in Volts
Distance in CM	1	0.03	30000
Distance in Meters	1		3000000
Distance in Nanometer	4.9		0.0147
Distance in inches	4		304800
Distance in microns	1		3
Distance in Angstroms	1500		0.45

Local Relative Humidity

Quantity	Enter	Results

HANDY DISTANCE CONVERSION HELP

Distance Units	Distance Input 1	Distance Conversion To CM for Reference
Distance in CM	100	100
Distance in Meters	1	100
Distance in Nanometer	20	0.000002
Distance in inches	39.37	99.9998
Distance in microns	1000000	100
Distance in Angstroms	1000	0.00001

Unpro

Air	0.03
Alumina Al203	0.016-0.06
Ge	0.1
Si Silicon	0.3
GaA[s]	0.4
FR4	~0.44-0.47
Barium Titanate	0.6 - 0.95
BCB*	2
SiN	6
SiCOH	8.0-9.0
Si3N4	10
SiO2	11
Marlex HDPE	0.2
Low Density Polyethylene	0.197-.37
Polyethylene PE & XLPE	.23-0.5
Polystyrene	0.197 - 0.25

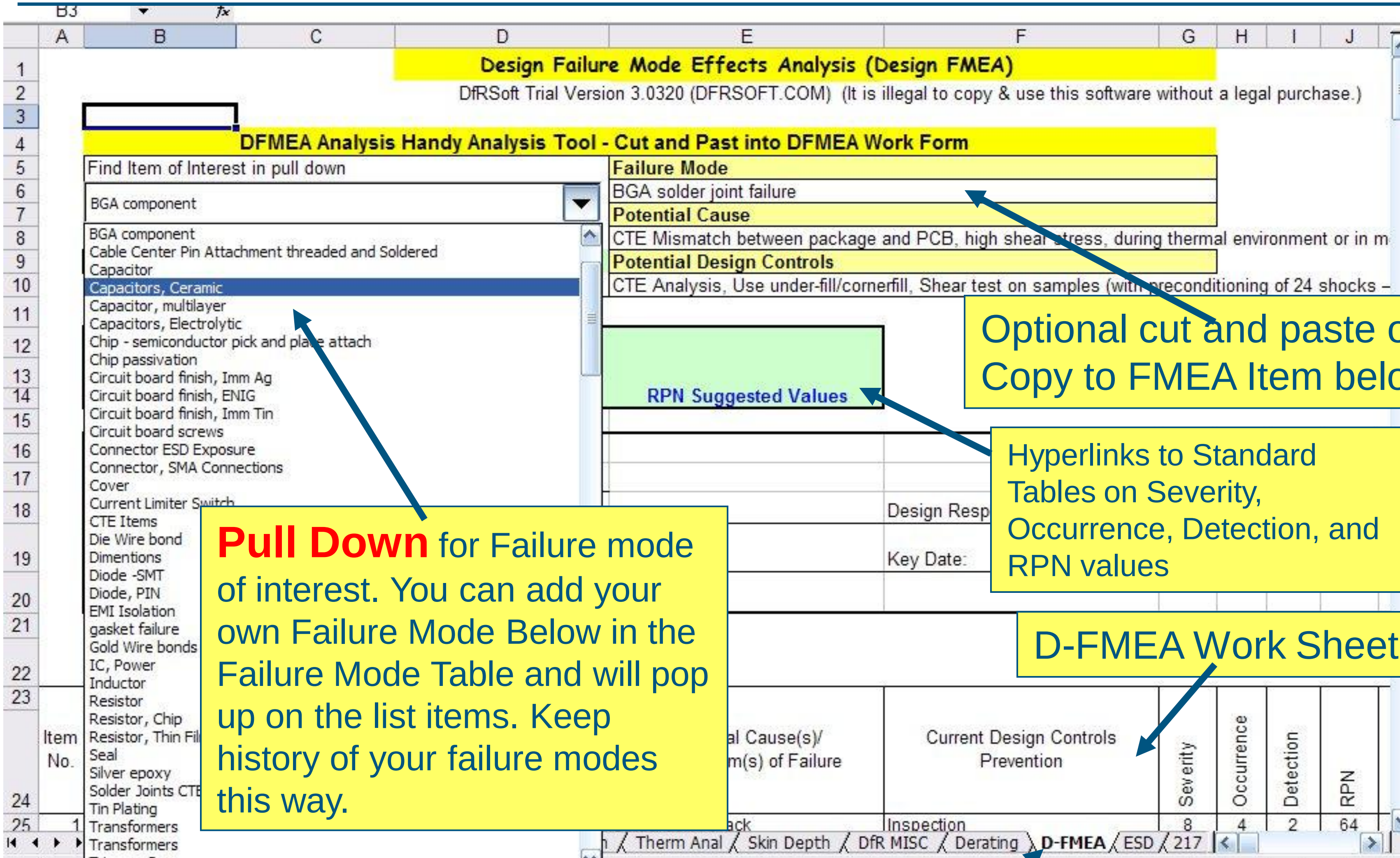
Field Returns / Avail & Spares / Rel Growth / Therm Anal / Skin Depth \ DfR MISC / Derating / D-FMEA / ESD / 217 T&E / TSS / Notes

Dielectric Breakdown any pressure Pashen's Law

Dielectric Breakdown Tool at any pressure in air. Handy look up tables available for different materialsv

DfR Misc Page

Design Failure Modes Effects Analysis Work Sheet



Optional cut and paste or Copy to FMEA Item below

Hyperlinks to Standard Tables on Severity, Occurrence, Detection, and RPN values

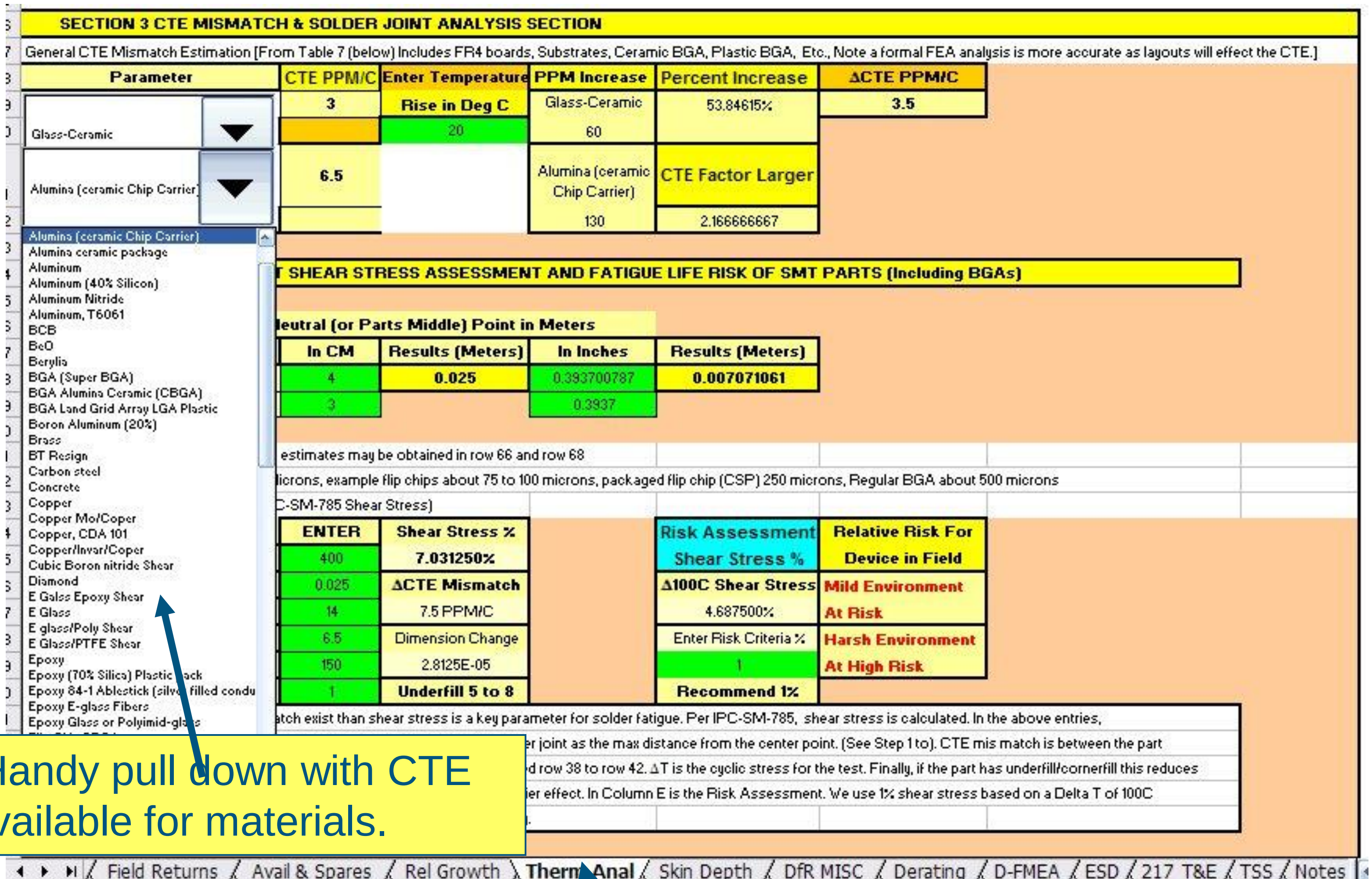
Pull Down for Failure mode of interest. You can add your own Failure Mode Below in the Failure Mode Table and will pop up on the list items. Keep history of your failure modes this way.

D-FMEA Work Sheet

D-FMEA Excel Tool

Various Thermal Models

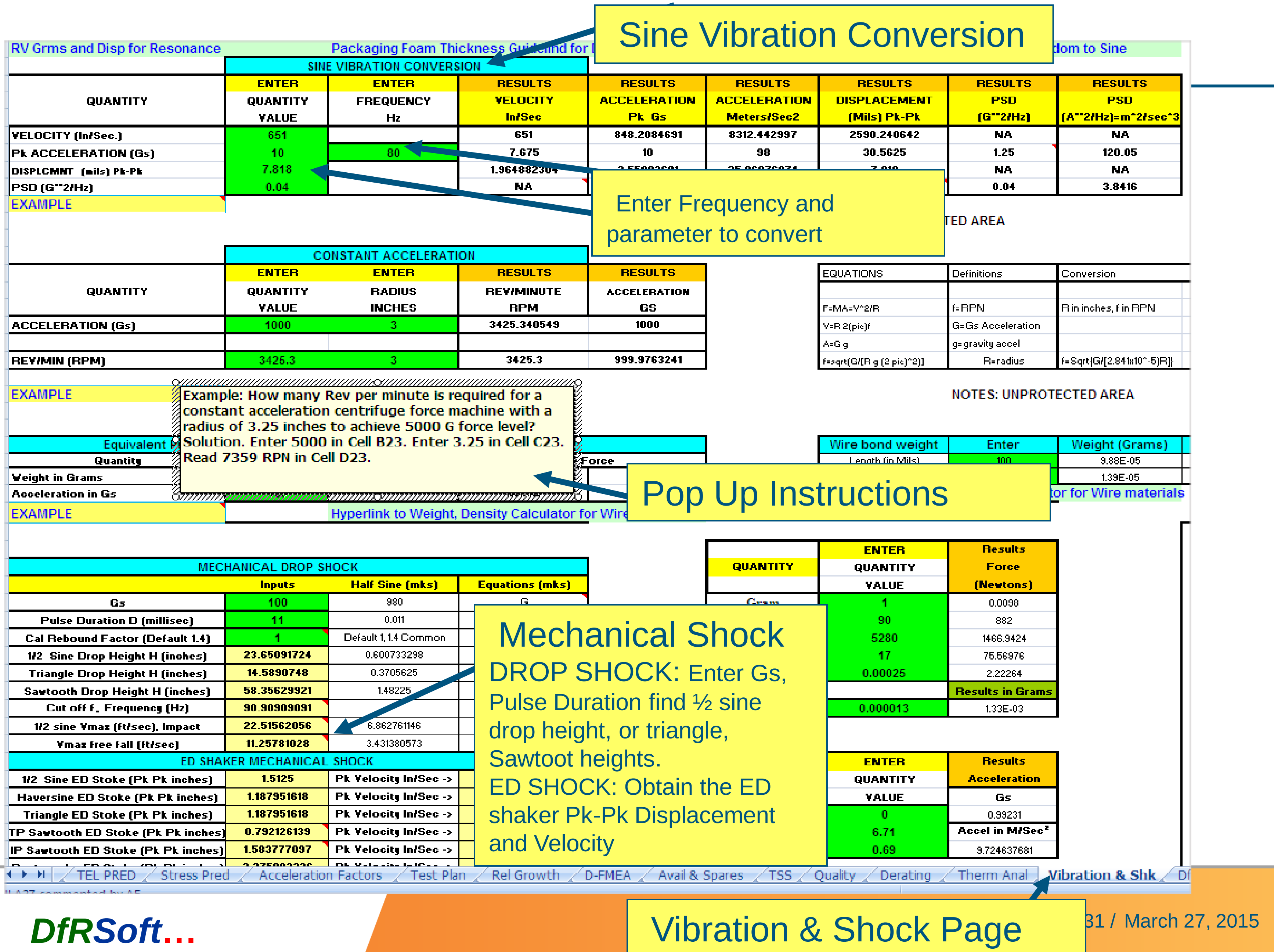
Find relevant tables for CTE mismatch items such as ceramic part and circuit board



Handy pull down with CTE available for materials.

Therm Anal Work Sheet

Vibration & Shock Tools



SINE VIBRATION CONVERSION

QUANTITY	ENTER QUANTITY VALUE	ENTER FREQUENCY Hz	RESULTS VELOCITY In/Sec	RESULTS ACCELERATION Pk Gs	RESULTS ACCELERATION Meters/Sec2	RESULTS DISPLACEMENT (Mils) Pk-Pk	RESULTS PSD (G^2/Hz)	RESULTS PSD (A^2/Hz)=m^2/sec^3
VELOCITY (In/Sec.)	651		651	848.2084691	8312.442997	2590.240642	NA	NA
Pk ACCELERATION (Gs)	10	80	7.675	10	98	30.5625	1.25	120.05
DISPLCMNT (mils) Pk-Pk	7.818		1.964882304	[illegible]	[illegible]	[illegible]	NA	NA
PSD (G^2/Hz)	0.04		NA	[illegible]	[illegible]	[illegible]	0.04	3.8416

CONSTANT ACCELERATION

QUANTITY	ENTER QUANTITY VALUE	ENTER RADIUS INCHES	RESULTS REV/MINUTE RPM	RESULTS ACCELERATION GS
ACCELERATION (Gs)	1000	3	3425.340549	1000
REV/MIN (RPM)	3425.3	3	3425.3	999.9763241

EQUATIONS	Definitions	Conversion
F=MA=V^2/R	f=RPN	R in inches, f in RPN
V=R 2(pi)f	G=Gs Acceleration	
A=G g	g=gravity accel	
f=sqrt(G/(R g (2 pi)^2))	R=radius	f=Sqrt(G/(2.841x10^-5)R))

Wire bond weight	Enter	Weight (Grams)
Length (in Mils)	100	9.88E-05
		1.39E-05

MECHANICAL DROP SHOCK

	Inputs	Half Sine (mks)	Equations (mks)
Gs	100	980	G
Pulse Duration D (millisec)	11	0.011	
Cal Rebound Factor (Default 1.4)	1	Default 1, 1.4 Common	
1/2 Sine Drop Height H (inches)	23.65091724	0.600733298	
Triangle Drop Height H (inches)	14.5890748	0.3705625	
Sawtooth Drop Height H (inches)	58.35629921	1.48225	
Cut off f_c Frequency (Hz)	90.90909091		
1/2 sine Vmax (ft/sec), Impact	22.51562056	6.862761146	
Vmax free fall (ft/sec)	11.25781028	3.431380573	

ED SHAKER MECHANICAL SHOCK

1/2 Sine ED Stoke (Pk Pk inches)	1.5125	Pk Velocity In/Sec ->
Haversine ED Stoke (Pk Pk inches)	1.187951618	Pk Velocity In/Sec ->
Triangle ED Stoke (Pk Pk inches)	1.187951618	Pk Velocity In/Sec ->
TP Sawtooth ED Stoke (Pk Pk inches)	0.792126139	Pk Velocity In/Sec ->
IP Sawtooth ED Stoke (Pk Pk inches)	1.583777097	Pk Velocity In/Sec ->

QUANTITY	ENTER QUANTITY VALUE	Results Force (Newtons)
Gram	1	0.0098
	90	882
	5280	1466.9424
	17	75.56976
	0.00025	2.22264
		Results in Grams
	0.000013	1.33E-03

ENTER QUANTITY VALUE	Results Acceleration Gs
0	0.99231
6.71	Accel in M/Sec²
0.69	9.724637681

DfRSoft...

Vibration & Shock Page
PSD Analysis

PSD Analysis, Obtain specta, Grms content, Max displacement and Max velocity

Grms Results Content	Avg Displacement Inches pk-pk	Max Displacement Inches pk-pk Likely Max Pk-Pk	Max Vel" Inches/sec Likely Max Vel
		0.054507971	6.451403065
		Possible Max Pk-Pk	Possible Max Vel.
8.422403	0.040880978	0.081761957	8.601870754

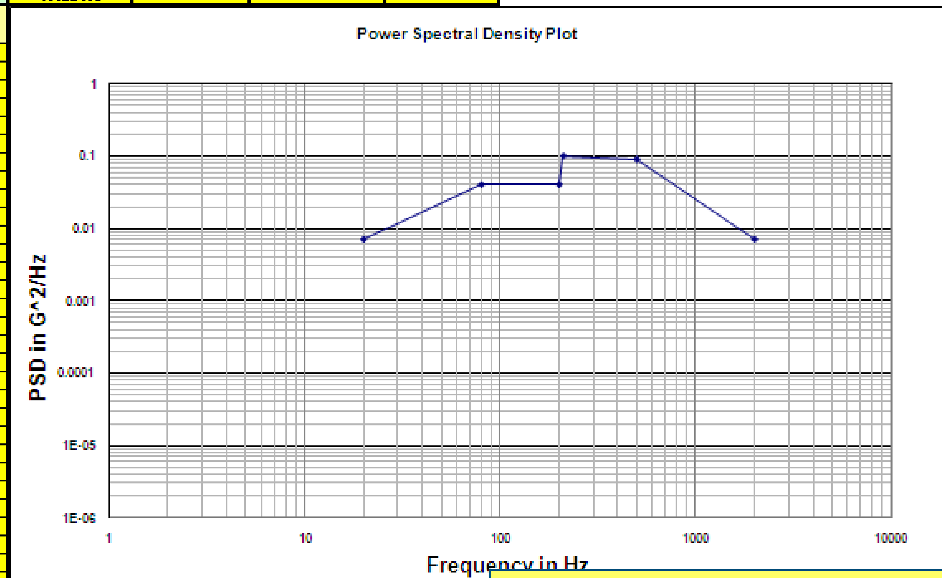
ARBITRARY PSD RANDOM VIBRATION SPECTRAL ANALYSIS

ASD/PSD ANALYSIS

ENTER FREQ(Hz)	ENTER PSD(G^2/Hz)	Cumulative Grms Results	dB/OCT Results
20	0.007		
80	0.04	1.164306609	3.784809757
200	0.04	2.481050157	0
210	0.1	2.610140151	56.53413956
500	0.09	5.842145432	-0.365609854
2000	0.007	8.422403284	-5.545722347

COMMENT

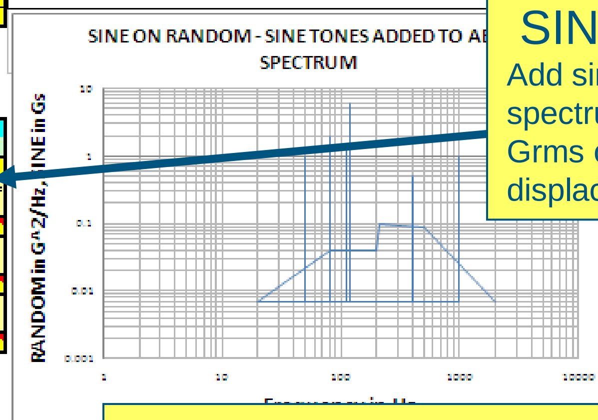
PSD Analysis, Enter arbitrary specta frequency and PSD, ASD Levels

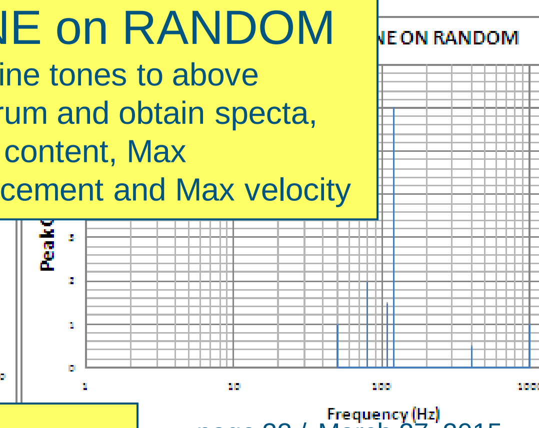


SINE ON RANDOM (Add SineTones to Above Random Spectrum)

SINE ON RANDOM ANALYSIS

ENTER FREQ(Hz)	ENTER PEAK G ACCELERATION	SINE ON RANDOM RESULTS	
50	1	Grms Results Content	Avg. Displacement Pk-Pk Inches
80	2	9.652987	0.058267
110	1.5	Max Velocity Likely in/s	Max Displacement Likely Pk-Pk in
120	6	10.232274	0.071894
400	0.5	Max Velocity Possible in/s	Max Displacement Possible Pk-Pk In
1000	1	13.643032	0.099148



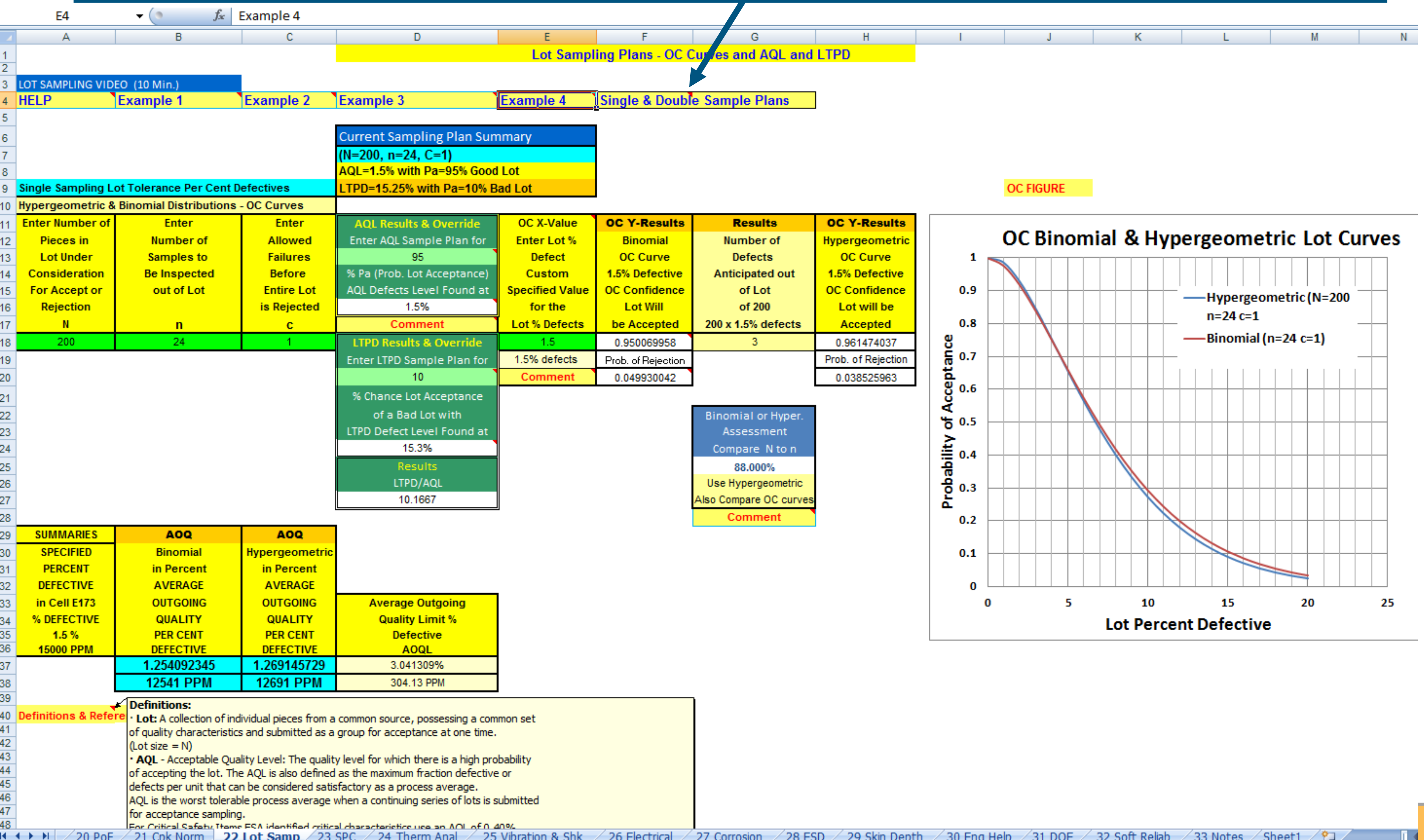


SINE on RANDOM Add sine tones to above spectrum and obtain specta, Grms content, Max displacement and Max velocity

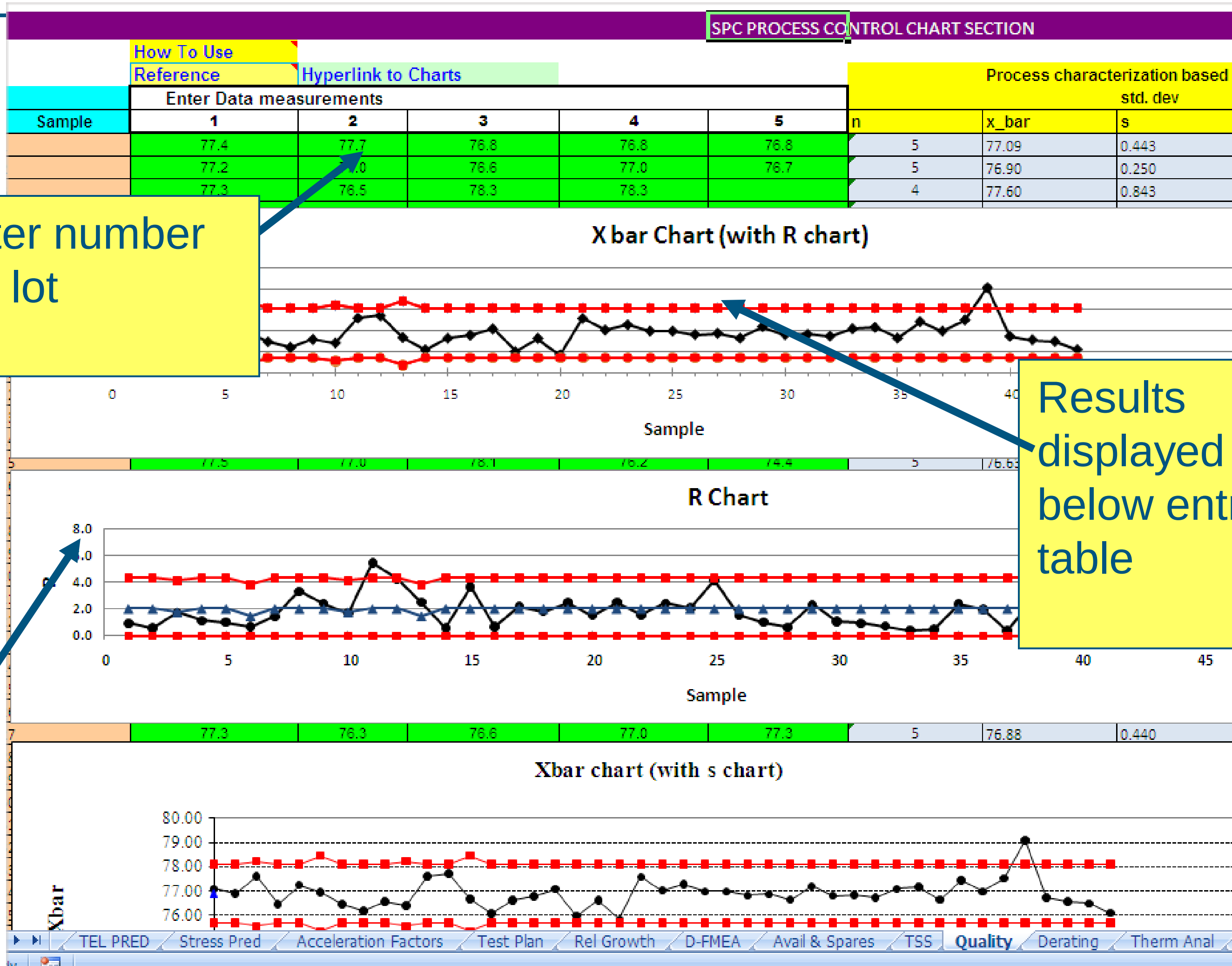
TEL PRED | Stress Pred | Acceleration Factors | Test Plan | ating | Therm Anal | Vibration & Shk

Vibration & Shock Page

Lot Sampling – Made easy with video instructions and multiple examples



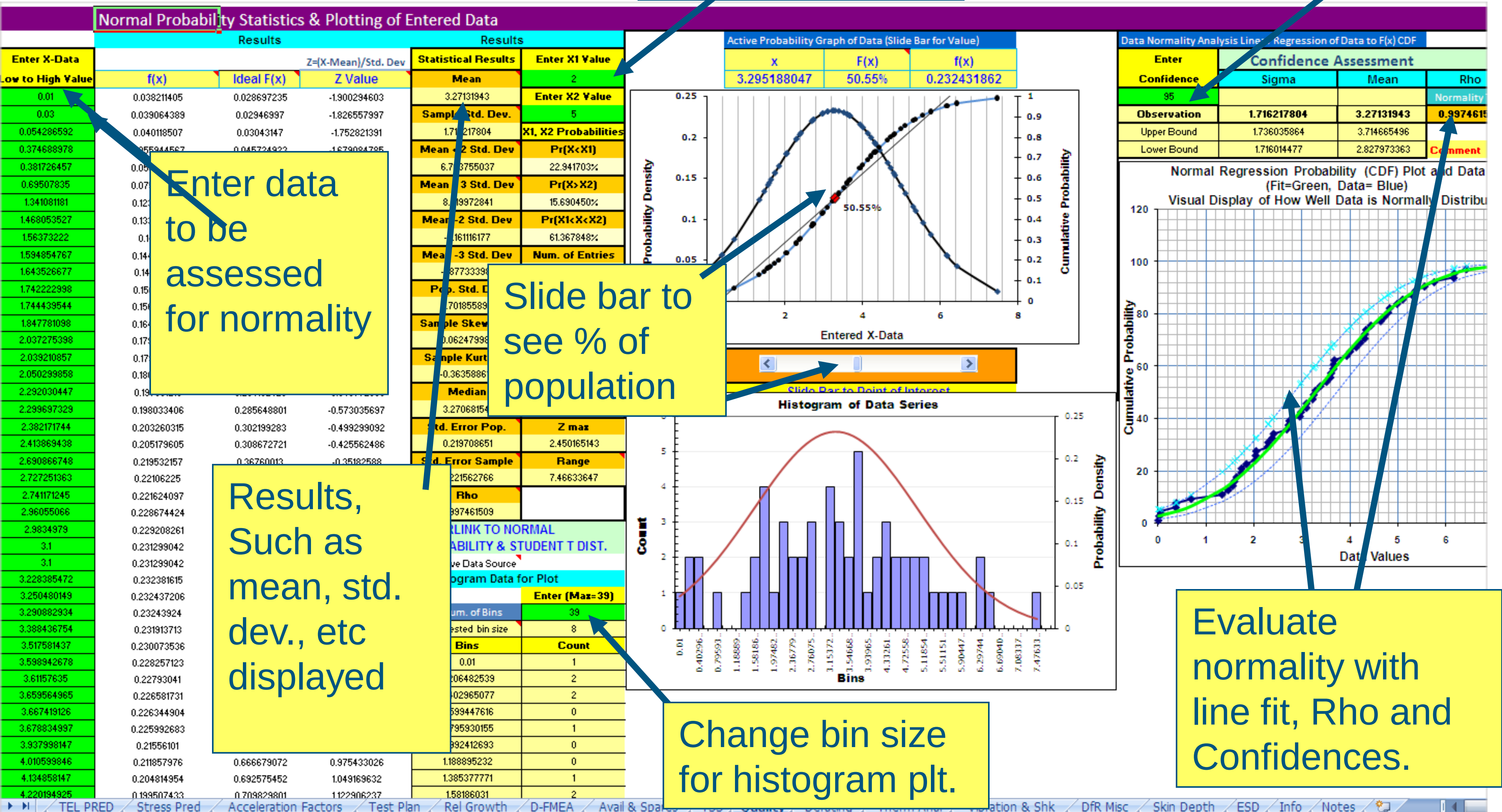
SPC Quality X bar, R Charts



Enter number per lot

Results displayed below entry table

Quality - Normal Distribution Analysis



DOE : Design of Experiments with Multiple Regression Analysis

- Numerous Arrays Available, Simple Data Entry

DOE For 4 Factors and 2 Levels, This is 1/2 Factorial Factorial Design (8 Runs) (A full factorial would require 16 Runs)

Enter 4 Factors and 2 Levels

Enter Factor Name	Factor Letter	Enter Lo Setting	Enter Hi Setting
Current	A	3	5
Voltage	B	100	200
Pwr Density	C	4	5
Speed	D	15	25

Instructions

Factor Assignment

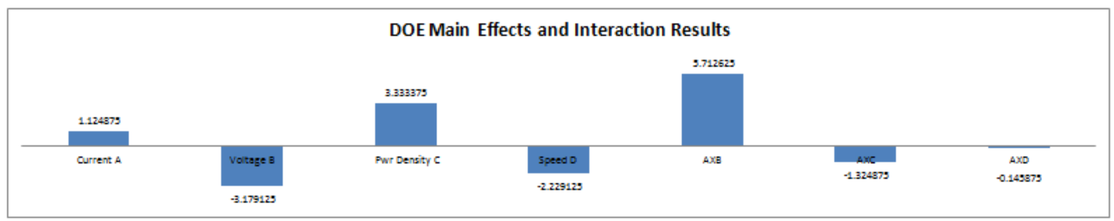
		Main Effects				Interactions		
Run Num.	Enter Run Order	Current A	Voltage B	Pwr Density C	Speed D	E E=AB	F F=AC	G G=AD
1		3	100	4	15	+	+	+
2		5	100	4	25	-	-	+
3		3	200	4	25	-	+	-
4		5	200	4	15	+	-	-
5		3	100	5	25	+	-	-
6		5	100	5	15	-	+	-
7		3	200	5	15	-	-	+
8		5	200	5	25	+	+	+

Enter Measurement Response Results (up to 8 replication runs)

Run Num.	Enter Results 1	Enter Results 2	Enter Results 3	Enter Results 4	Enter Results 5	Enter Results 6	Enter Results 7	Enter Results 8	Results AVE	Std.Dev.	Signal to Noise (S/N)
1	21.317	21.4							21.3585	0.05869	2.56100765
2	15.833	15.9							15.8665	0.04738	2.52492133
3	10.367	10.4							10.3835	0.02333	2.64834483
4	20.75	20.8							20.775	0.03536	2.76908603
5	23.967	23.9							23.9335	0.04738	2.70344641
6	20.2	20.3							20.25	0.07071	2.45694003
7	17.15	17.1							17.125	0.03536	2.68517557
8	20.417	20.4							20.4085	0.01202	3.22987716

Name	Effects	Effect Order
Current A	1.124875	1
Voltage B	-3.179125	1
Pwr Density C	3.333375	1
Speed D	-2.229125	1
AXB	5.712625	2
AXC	-1.324875	2
AXD	-0.145875	3

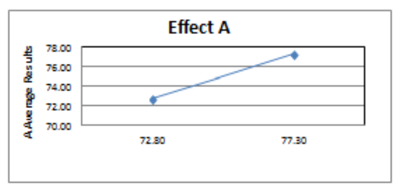
Comment



ANOVA Table

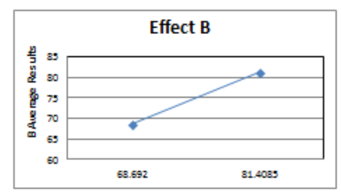
	SS	Df	MS	F	Alpha
Current A	2.53068753	1	2.530687531	4.81301E+12	2.90183E-07
Voltage B	20.2136715	1	20.21367153	3.84435E+13	1.02676E-07
Pwr Density C	22.2227778	1	22.22277778	4.22646E+13	9.79246E-08
Speed D	9.93799653	1	9.937996531	1.89007E+13	1.46434E-07
AXB	65.2681688	1	65.26816878	1.24131E+14	5.714E-08
AXC	3.51058753	1	3.510587531	6.67664E+12	2.46378E-07
AXD	0.04255903	1	0.042559031	80941231959	2.23767E-06
Total	123.7	7	Error	5.25802E-13	
	Avg of Means	18.7625625	Total sum	123.7264487	

MS - Mean Sum of Squares
Df - Degrees of freedom
F - F-test characteristic
SS - Sum of Squares
Alpha = F-test probability



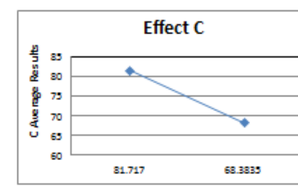
A Effect = 1.125	
Current A LO	Current A HI
72.80	77.30

Comment



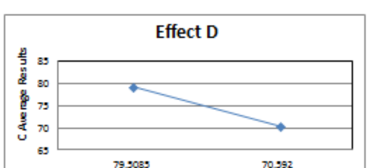
B Effect = -3.179	
Voltage B LO	Voltage B HI
68.692	81.4085

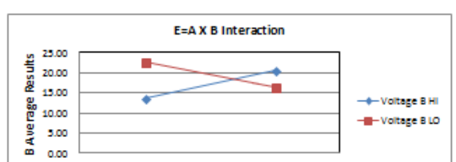
Comment

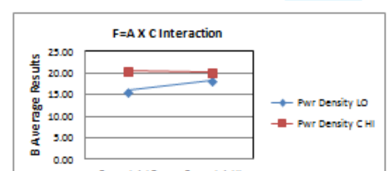


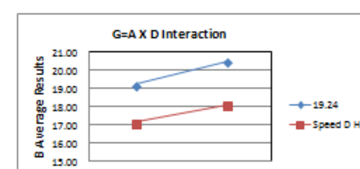
C Effect = 3.333	
Pwr Density C LO	Pwr Density C HI
81.717	68.3835

Comment









20 PoF | 21 Cpk Norm | 22 Lot Samp | 23 SPC | 24 Therm Anal | 25 Vibration & Shk | 26 Electrical | 27 Corrosion | 28 ESD | 29 Skin Depth | 30 Eng Help | 31 DOE | 32 Soft Reliab | 33 Notes | Sheet1

Ready

Software Reliability G-O Model

Software Reliability Growth Modeling

G-O Software Reliability Growth Model | **Cum Software Rel Growth Models (Duane, Logarithmic, Polynomial, Crow/AMSAA)**

Goel-Okumoto (G-O) NHPP Software Reliability Growth Model

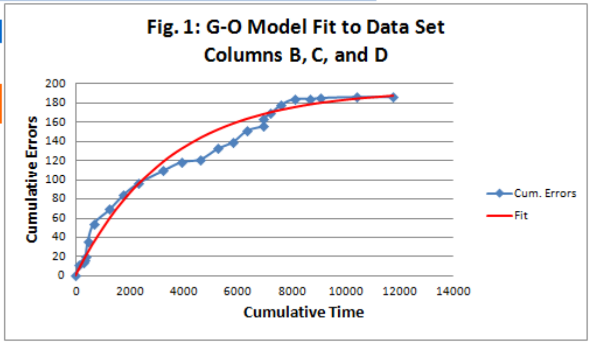
DfRSoft Model Information:

G-O Software Growth Mode Results		
Errors=A(1-Exp(-B x Time))		
A	193.69296	Est. Defects - Faults
B	0.000291266	Fault error rate
RSQ	95.90%	Fit Value
Inst. Failure Rate	0.001858398	at 11777 Hrs.
Inst. Achieve MTBF	538.0979803	at 11777 Hrs.

Results see Fig. 1, -4

G-O model errors left	7.69296	Total Errors =	193.69296
Enter upper bd. Conf. on Errors	95	Max Errors Left	13.1
DfRSoft Slope Ratio <5% Criteria for Test Completion	1.3264%	Test Index (2 to 5)	3

Time Left Comment (see comment and use Col. H)



Data Entry Area For Go Model

Leave all lines blank that are not in use

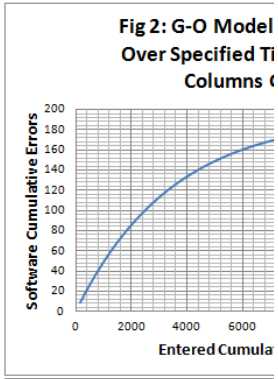
Results in Fig. 1

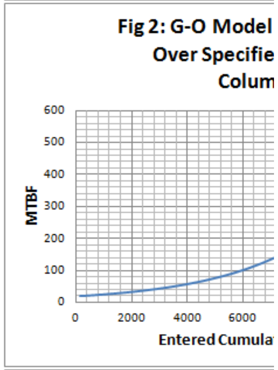
Num.	Enter (or leave blankk) Cumulative Time	Enter Software Cum. Errors	G-O Model Data Fit
1	0	0	0
2	131	11	7.251304642
3	283	14	15.32548563
4	330	16	17.75061209
5	373	20	19.94045088
6	458	36	24.18933777
7	680	54	34.80279201
8	1278	69	60.20170136
9	1782	84	78.42749919
10	2332	96	95.48950453
11	3248	109	118.486168
12	3928	118	131.9993403
13	4641	121	143.5685706
14	5272	132	151.9838855
15	5845	139	158.3950704
16	6370	151	163.40021
17	6963	156	168.2054751
18	6964	163	168.2128977
19	7250	169	170.2494397
20	7633	178	172.7240854
21	8130	184	175.5500497

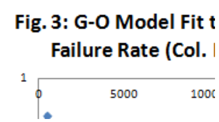
Extrapolating The Growth Prediction to a Later Time

Enter End Time: 11777

Plot (Cell H19) Cumulative Time	Errors Prediction at End Time	Cumulative Mean Time Between Failures (Errors) Cum MTBF	Instantaneous Failure Rate Fit Results	Average Failure Per Year Enter Hrs/Yr. 8760	Inst. MTBF Enter Use Duty Cycle in Percent 100	Instaneous Fail Rate Data Inst
159.1486486	8.773644081	18.14	0.055128612	482.92664	18.139401	0.083969466
318.2972973	17.14987139	18.56	0.05263147	461.0516763	19.000039	0.019736842
477.4459459	25.14668359	18.99	0.05024744	440.1675755	19.901511	0.042553191
636.5945946	32.7812669	19.42	0.047971399	420.2294546	20.845754	0.093023256
795.7432432	40.07002909	19.86	0.045798455	401.1944641	21.834798	0.188235294
954.8918919	47.0286347	20.30	0.043723938	383.021695	22.870767	0.081081081
1114.040541	53.67203873	20.76	0.041743389	365.6720916	23.955889	0.025083612
1273.189189	60.01451874	21.21	0.039852553	349.1083674	25.092495	0.029761905
1432.337838	66.06970559	21.68	0.038047366	333.2949245	26.283029	0.021818182
1591.486486	71.85061271	22.15	0.036323947	318.1977777	27.530048	0.01419214
1750.635135	77.36966404	22.63	0.034678594	303.7844813	28.836233	0.013235294
1909.783784	82.63872078	23.11	0.033107769	290.0240591	30.204391	0.004207574
2068.932432	87.66910686	23.60	0.031608098	276.886938	31.637462	0.017432647
2228.081081	92.47163324	24.09	0.030176357	264.3448846	33.138527	0.012216405
2387.22973	97.05662123	24.60	0.028809469	252.3709443	34.71081	0.022857143
2546.378378	101.4339246	25.10	0.027504496	240.9393836	36.357692	0.008431703
2705.527027	105.6129507	25.62	0.026258634	230.0256343	38.082712	#N/A
2864.675676	109.6026809	26.14	0.025069206	219.6062414	39.889577	0.020979021
3023.824324	113.4116896	26.66	0.023933654	209.6588123	41.782169	0.023498695
3182.972973	117.048163	27.19	0.02284954	200.1619684	43.764558	0.012072435







DfRSoft… Overview Information

- This overview shows only a select fraction of the tools available in DfRSoft. Details available in the website:

  www.dfrsoft.com

- A free 30 day trial copy is available with professional help from:
  - dfrsoft@gmail.com or support@dfrsoft.com
  - Call to inquire (617) 943-9034

  - We appreciate customer feedback and can respond quickly to any requests. Please let us know how we can improve our software for your needs or if you have questions.

Thank You

Dr. Alec Feinberg

Author: Design for Reliability,
Founder of DfRSoft