SMART|LD Example User Exceedance

SMART Short Course

The Aircraft Airworthiness & Sustainment Conference

Grapevine, Texas – March 21, 2016

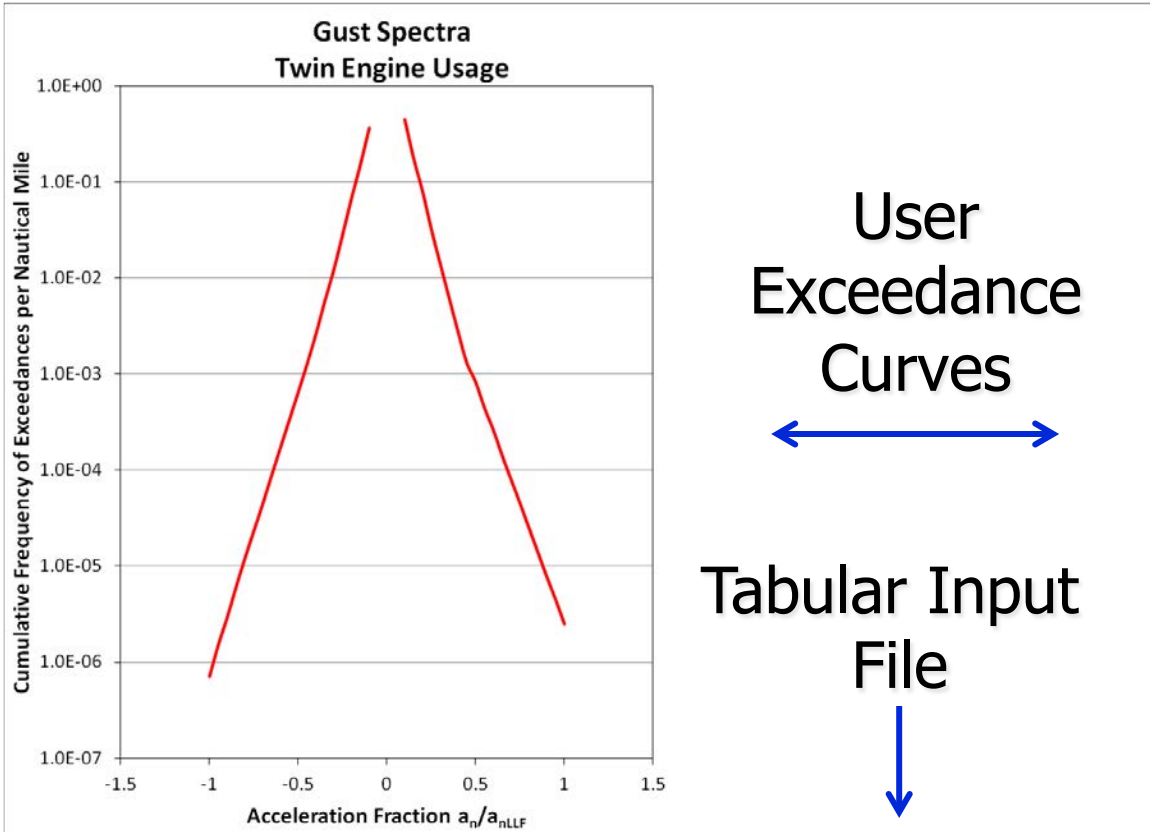
Problem Overview

Twin engine unpressurized airplane with a history of fatigue cracks in the wing spar cap

Problem Overview

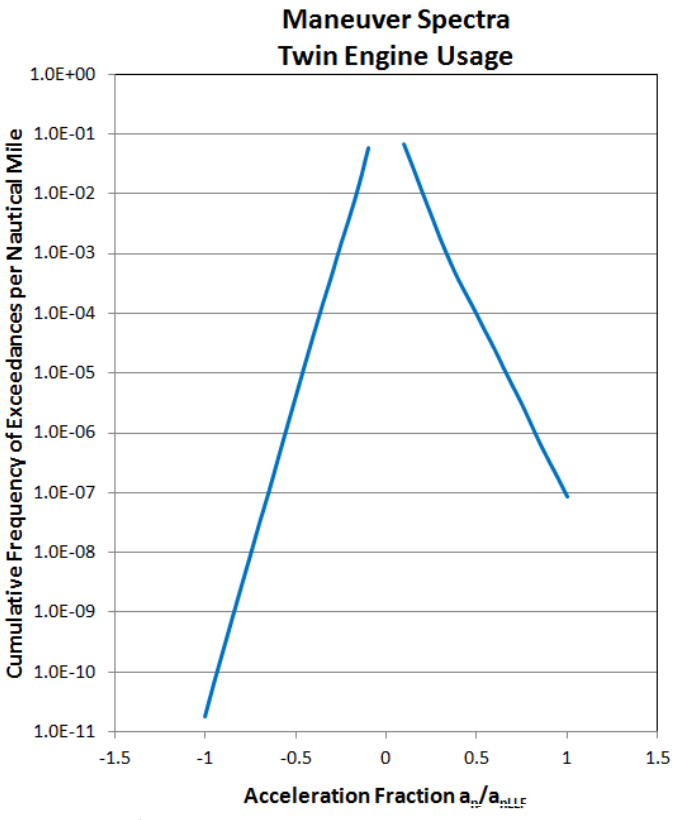
Input Parameter	Value
Gust/Maneuver Load exceedances	User Exceedance Curve
Sink Rate	Probabilistic sink rate
Design Maneuver Load Limit Factors	3.80, -1.50
Design Gust Load Limit Factors	3.40, -1.40
One g stress	6500, 7000
Ground Stress	-2000
Aircraft Velocity	V_c = 200
Damage Index	Normal distribution, Mean 1.0, Standard deviation 0.1
SN Curve	PSN-ASTM, SSF =3.5

Problem Overview



User Exceedance Curves

Tabular Input File



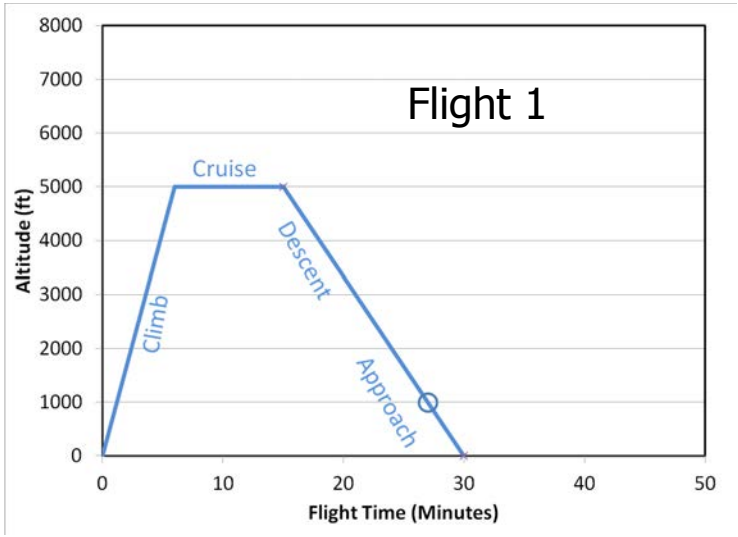
GUST

a.f	freq.	inc/nm cov	a.f	freq.	inc/nm cov
0.10	4.45E-01	12	-0.10	3.60E-01	12
0.15	1.75E-01	12	-0.15	1.50E-01	12
0.20	8.00E-02	12	-0.20	6.68E-02	12
o	o	o	o	o	o
o	o	o	o	o	o

MAN

a.f	freq.	inc/nm cov	a.f	freq.	inc/nm cov
0.10	6.90E-02	12	-0.10	5.90E-02	12
0.15	2.80E-02	12	-0.15	1.50E-02	12
0.20	1.10E-02	12	-0.20	4.50E-03	12
o	o	o	o	o	o
o	o	o	o	o	o

Define Flight Matrices



Segment	Weight	KEAS	% Duration
CLIMB	6580	140	0.20
CRUISE	6440	160	0.50
DESCENT	6300	180	0.20
APPROACH	6160	120	0.10

V_C = 200 KEAS

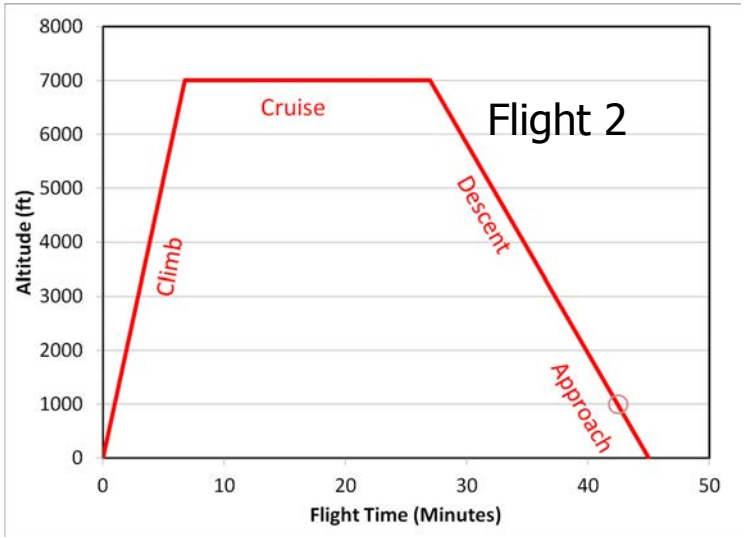
MTOW = 7000 lb

Sort matrix in ascending order for speed & weight

		Average Speed During Flight, % Max Takeoff Weight				
Flight Time (hrs)	% of Flights	0.88	0.90	0.92	0.94	0.96
0.5	1.0	0.10	0.20	0.50	0.20	0.0

		Average Speed During Flight, % Design Velocity				
Flight Time (hrs)	% of Flights	0.60	0.70	0.80	0.90	1.00
0.5	1.0	0.10	0.20	0.50	0.20	0.0

Define Flight Matrices



Segment	Weight	KEAS	% Duration
CLIMB	6720	140	0.15
CRUISE	6580	160	0.60
DESCENT	6440	180	0.15
APPROACH	6300	120	0.10

V_C = 200 KEAS

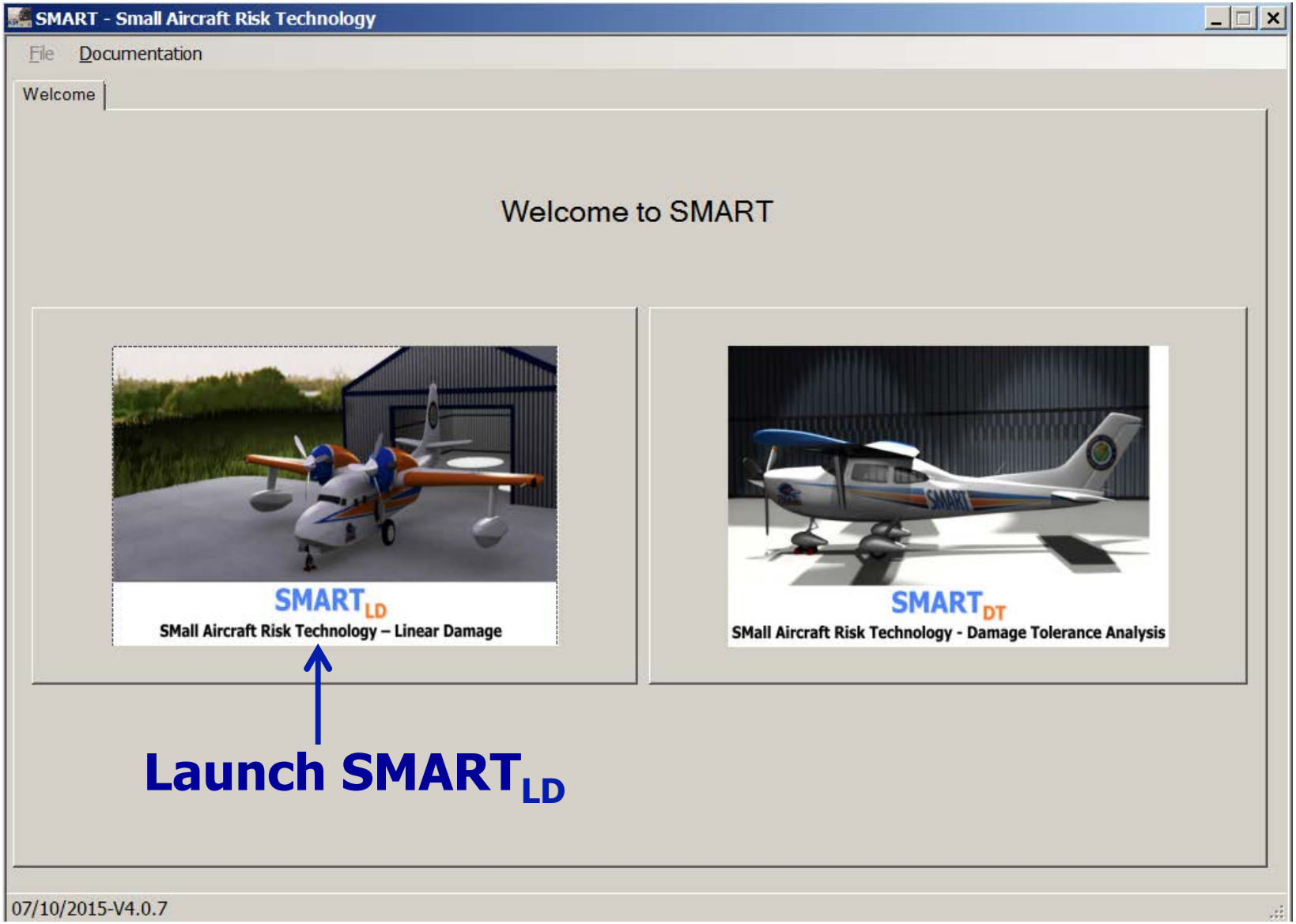
MTOW = 7000 lb

Sort matrix in ascending order for speed & weight

		Average Speed During Flight, % Max Takeoff Weight				
Flight Time (hrs)	% of Flights	0.80	0.90	0.92	0.94	0.96
0.75	1.0	0.0	0.10	0.15	0.60	0.15

		Average Speed During Flight, % Design Velocity				
Flight Time (hrs)	% of Flights	0.600	0.70	0.80	0.90	1.00
0.75	1.0	0.10	0.15	0.60	0.15	0.00

SMART$_{LD}$ Input



Problem Definition

SMART - Small Aircraft Risk Technology

File Documentation

Begin | Usage Spectra

Name: Wing Spar

Aircraft Make: Acme

Aircraft Model: Sky Runner

Aircraft Serial No.: SR100

Aircraft TCDS: TCSR100

Use Previous Run

Browse...

Miner's Rule Damage Factor

Mean:

Std. Dev:

PDF/CDF

SN Curve

Browse...

Analysis Type

No. Simulations:

Seed: 1393925

Stress Severity Factor Calculation

User Input PSN Curves Direct Input

Alpha: SSF:

Beta:

Theta:

Thickness:

Width:

Diameter:

Edge Distance:

Lead Transfer:

Description:

This is an example problem. Wing spar cracking of the Acme Sky Runner.

07/10/2015-V4.0.7

Miner's Rule

SMART - Small Aircraft Risk Technology

File Documentation

Begin | Usage Spectra

Name: Wing Spar

Aircraft Make: Acme

Aircraft Model: Sky Runner

Aircraft Serial No.: SR100

Aircraft TCDS: TCSR100

Use Previous Run

Browse...

Description:

This is an example problem. Wing spar cracking of the Acme Sky Runner.

Miner's Rule Damage Factor: NORMAL

Mean: 1.0

Std. Dev: 0.1

PDF/CDF

SN Curve

Browse...

Analysis Type

No. Simulations:

Seed: 4105001

Stress Severity Factor Calculation

User Input | PSN Curves | Direct Input

Alpha: SSF:

Beta:

Theta:

Thickness:

Width:

Diameter:

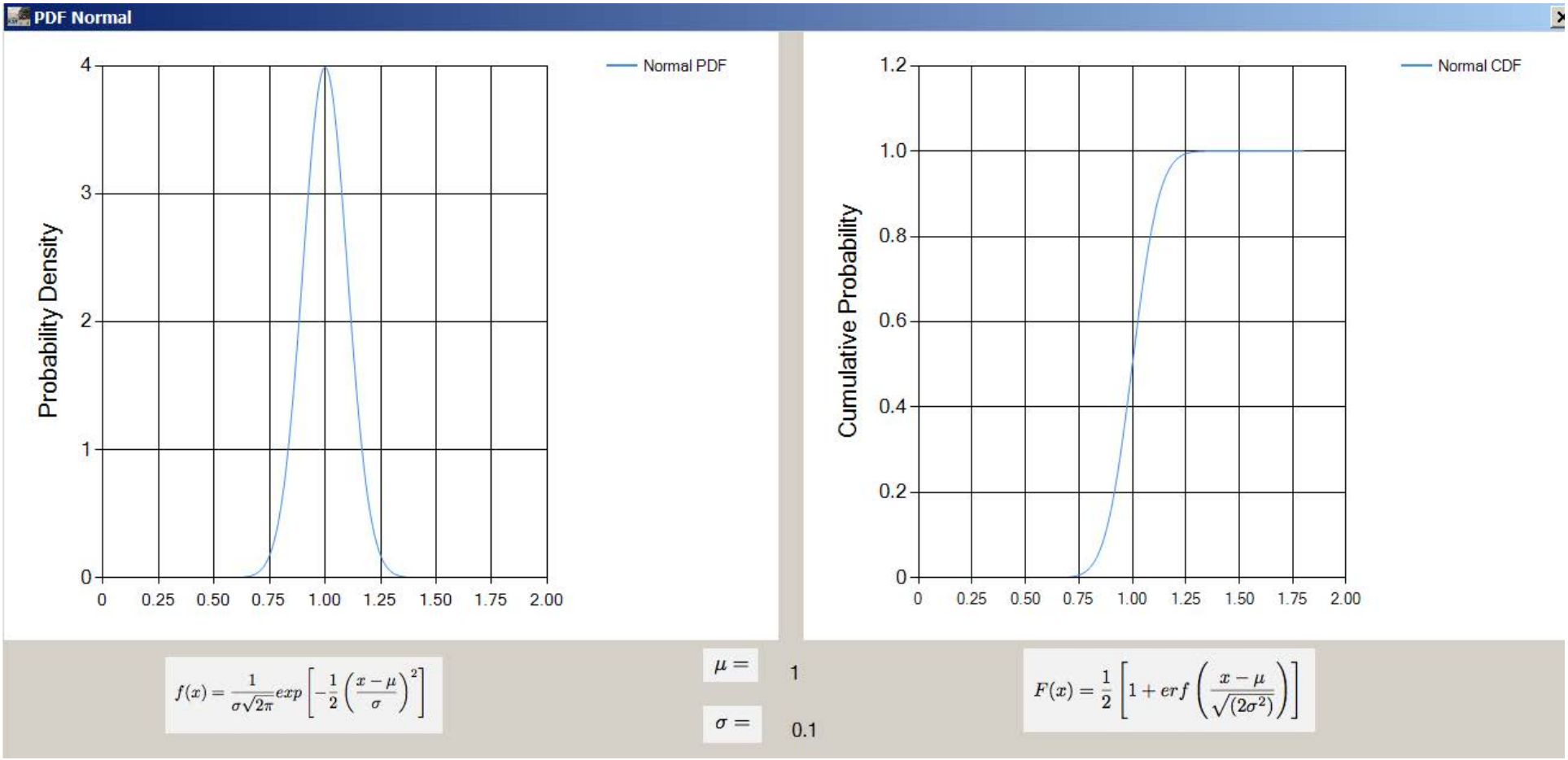
Edge Distance:

Load Transfer:

Plot PDF/ CDF

07/10/2015-V4.0.7

Miner's Rule


PDF Normal
Normal PDF
Probability Density
4
3
2
1
0
0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Normal CDF
Cumulative Probability
1.2
1.0
0.8
0.6
0.4
0.2
0
$f(x) = \frac{1}{\sigma\sqrt{2\pi}} exp\left[-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right]$
$\mu =$
1
$\sigma =$
0.1
$F(x) = \frac{1}{2}\left[1 + erf\left(\frac{x-\mu}{\sqrt{(2\sigma^2)}}\right)\right]$

SN Curve, SSF

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File Documentation

Begin | Usage Spectra

Log N = A + B(log S)

Name: Wing Spar

Aircraft Make: Acme

Aircraft Model: Sky Runner

Aircraft Serial No.: SR100

Aircraft TCDS: TCSR100

Use Previous Run

Browse...

Miner's Rule Damage Factor: NORMAL

Mean: 1.0

Std. Dev: 0.1

PDF/CDF

SN Curve: PSN_ASTM

Browse...

Analysis Type:

No. Simulations:

Seed: 4105001

Stress Severity Factor Calculation

User Input | PSN Curves | Direct Input

Alpha:

Beta:

Theta:

Thickness:

Width:

Diameter:

Edge Distance:

Load Transfer:

SSF: 3.5

Description:

This is an example problem. Wing spar cracking of the Acme Sky Runner.

07/10/2015-V4.0.7

Analysis Type

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File Documentation

Begin | Usage Spectra

Name: Wing Spar

Aircraft Make: Acme

Aircraft Model: Sky Runner

Aircraft Serial No.: SR100

Aircraft TCDS: TCSR100

Use Previous Run

Browse...

Description:

This is an example problem. Wing spar cracking of the Acme Sky Runner.

Miner's Rule Damage Factor: NORMAL

Mean: 1.0

Std. Dev: 0.1

PDF/CDF

SN Curve: PSN_ASTM

Browse...

Analysis Type: DAMAGE

No. Simulations: 20000

Seed: 4105001

Stress Severity Factor Calculation

User Input | PSN Curves | Direct Input

Alpha:

SSF: 3.5

Beta:

Theta:

Thickness:

Width:

Diameter:

Edge Distance:

Load Transfer:

07/10/2015-V4.0.7

User Exceedances

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File Documentation

Begin | Usage Spectra

Plot Exceedances

Load Spectrum: Browse... Transfer Factor: 1.0

Flight Hours for this Spectrum: Flight Hours per Flight:

Load Usages:

Usage Spectra

Aircraft Usage: USER_DEFINED

Plot Exceedances

Percent of Total Usage:

Exceedance COV 12.0

Design Maneuver Load Factor High: One G Stress (psi):

Design Gust Load Factor High: Average Velocity (Vno/Vmo(Knots)):

Design Maneuver Load Factor Low: Number of Flight Times:

Design Gust Load Factor Low: Number of Velocities:

Ground Stress (psi): Load Matrices Matrix

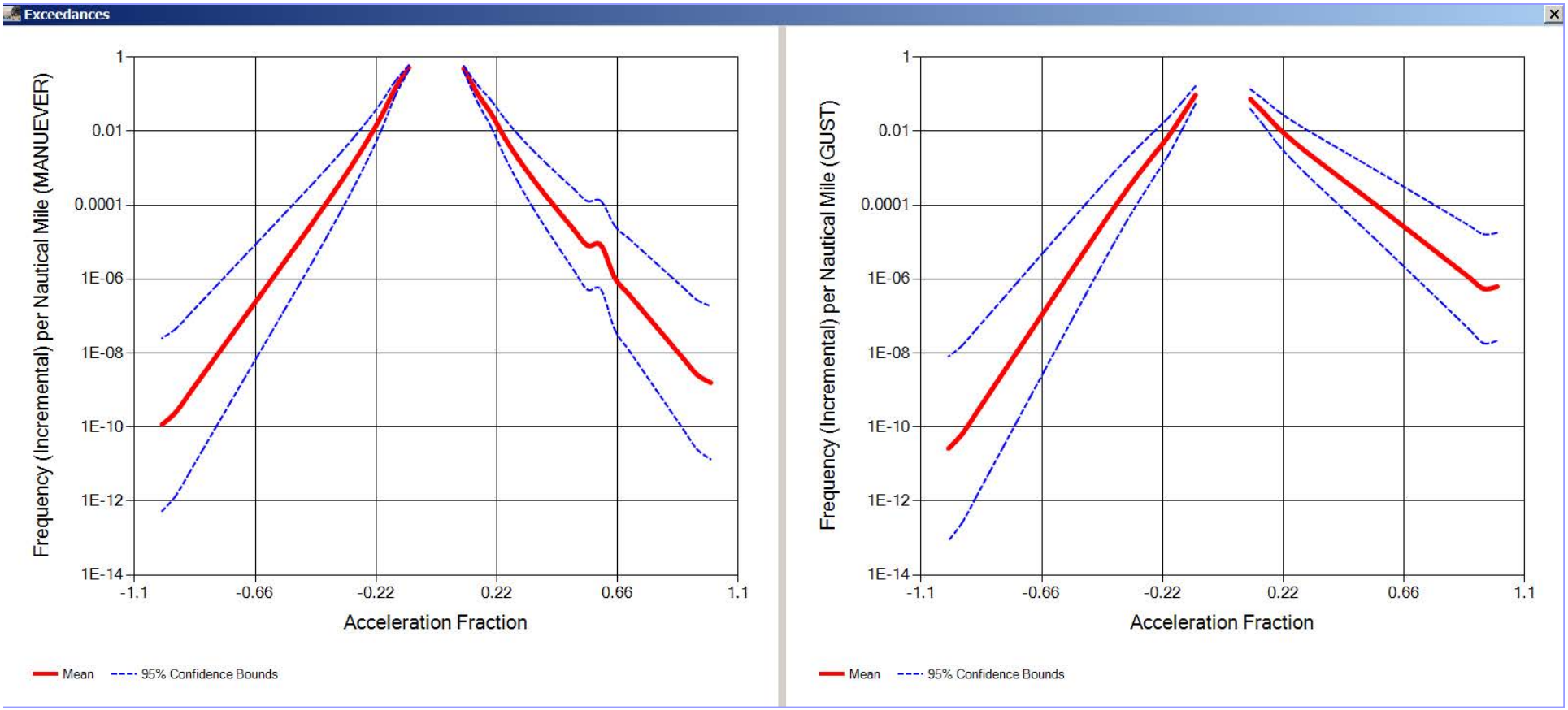
File: C:\Users\Desktop\SMART\Class\UserExceedance.exc Browse... Save Usage

Flight Variation

Deleted Usages

07/10/2015-V4.0.7

Exceedance Plots



Define Usage Spectra

Flight 1

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File Documentation

Begin | Usage Spectra

Load Spectrum: Browse... Transfer Factor: 1.0

Flight Hours for this Spectrum: Flight Hours per Flight:

Load Usages: USER

Usage Spectra

Aircraft Usage: USER_DEFINED — Plot Exceedances

Percent of Total Usage:	0.5	Exceedance COV	12.0
Design Maneuver Load Factor High:	3.8	One G Stress (psi):	6500.0
Design Gust Load Factor High:	3.4	Average Velocity (Vno/Vmo(Knots)):	180.0
Design Maneuver Load Factor Low:	-1.5	Number of Flight Times:	1
Design Gust Load Factor Low:	-1.4	Number of Velocities:	5
Ground Stress (psi):	-2000.0	Load Matrices	Matrix

File: C:\Users\Desktop\SMART\Class\User_exced.exc Browse... Save Usage

Flight Variation

Deleted Usages

07/10/2015-V4.0.7

Flight #1 Matrices

Matrix

Flight Times vs. Velocity

Flt.Time(hrs)	% of Flts.	%Vno or %Vmo	%Vno or %Vmo	%Vno or %Vmo	%Vno or %Vmo	%Vno or %Vmo
		0.60	0.70	0.80	0.90	1.00
0.50	1.0	0.10	0.20	0.50	0.2	0.0

Define velocity matrix #1

Flight Times vs. Weight

Flt.Time(hrs)	% of Flts.	%Max. Wt.	%Max. Wt.	%Max. Wt.	%Max. Wt.	%Max. Wt.
		0.88	0.90	0.92	0.94	0.96
0.50	1.0	0.10	0.20	0.50	0.20	0.0

Define weight matrix #1

Accept | Weight Matrix Same as Velocity Matrix | Save Matrices | Cancel

Define Usage Spectra

Flight 1

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File Documentation

Begin | Usage Spectra

Load Spectrum: Browse... Transfer Factor: 1.0

Flight Hours for this Spectrum: Flight Hours per Flight:

Load Usages: USER

Usage Spectra

Aircraft Usage: USER_DEFINED — Plot Exceedances

Percent of Total Usage: 0.5 — Exceedance COV 12.0

Design Maneuver Load Factor High: 3.8 — One G Stress (psi): 6500.0

Design Gust Load Factor High: 3.4 — Average Velocity (Vno/Vmo(Knots)): 180.0

Design Maneuver Load Factor Low: -1.5 — Number of Flight Times: 1

Design Gust Load Factor Low: -1.4 — Number of Velocities: 5

Ground Stress (psi): -2000.0 — Load Matrices — Matrix

File: C:\Users\Desktop\SMART\Class\User_exced.exc Browse... Save Usage

Flight Variation

Deleted Usages

07/10/2015-V4.0.7

Define Usage Spectra

Flight 2

SMART - Small Aircraft Risk Technology

File Documentation

Begin | Usage Spectra

Load Spectrum: Browse... Transfer Factor: 1.0

Flight Hours for this Spectrum: Flight Hours per Flight:

Load Usages:

USER
USER

Usage Spectra

Aircraft Usage: USER_DEFINED — Plot Exceedances

Percent of Total Usage:	0.5	Exceedance COV	12.0
Design Maneuver Load Factor High:	3.8	One G Stress (psi):	7000.0
Design Gust Load Factor High:	3.4	Average Velocity (Vno/Vmo(Knots)):	180.0
Design Maneuver Load Factor Low:	-1.5	Number of Flight Times:	1
Design Gust Load Factor Low:	-1.4	Number of Velocities:	5
Ground Stress (psi):	-2000.0	Load Matrices	Matrix

File: C:\Users\c82627\Desktop\SMART\Class\User_exced.exc Browse... Save Usage

Flight Variation

Deleted Usages

07/10/2015-V4.0.7

Flight #2 Matrices

Matrix

Flight Times vs. Velocity

Flt.Time(hrs)	% of Flts.	%Vno or %Vmo	%Vno or %Vmo	%Vno or %Vmo	%Vno or %Vmo	%Vno or %Vmo
		0.60	0.70	0.80	0.90	1.00
0.75	1.0	0.10	0.15	0.60	0.15	0.0

Define velocity matrix #2

Flight Times vs. Weight

Flt.Time(hrs)	% of Flts.	%Max. Wt.	%Max. Wt.	%Max. Wt.	%Max. Wt.	%Max. Wt.
		0.88	0.90	0.92	0.94	0.96
0.75	1.0	0.00	0.10	0.15	0.60	0.15

Define weight matrix #2

Accept | Weight Matrix Same as Velocity Matrix | Save Matrices | Cancel

Define Usage Spectra

Flight 2

SMART - Small Aircraft Risk Technology

File Documentation

Begin | Usage Spectra

Load Spectrum: Browse... Transfer Factor: 1.0

Flight Hours for this Spectrum: Flight Hours per Flight:

Load Usages:

USER
USER

Usage Spectra

Aircraft Usage: USER_DEFINED — Plot Exceedances

Percent of Total Usage:	0.5	Exceedance COV	12.0
Design Maneuver Load Factor High:	3.8	One G Stress (psi):	7000.0
Design Gust Load Factor High:	3.4	Average Velocity (Vno/Vmo(Knots)):	180.0
Design Maneuver Load Factor Low:	-1.5	Number of Flight Times:	1
Design Gust Load Factor Low:	-1.4	Number of Velocities:	5
Ground Stress (psi):	-2000.0	Load Matrices	Matrix

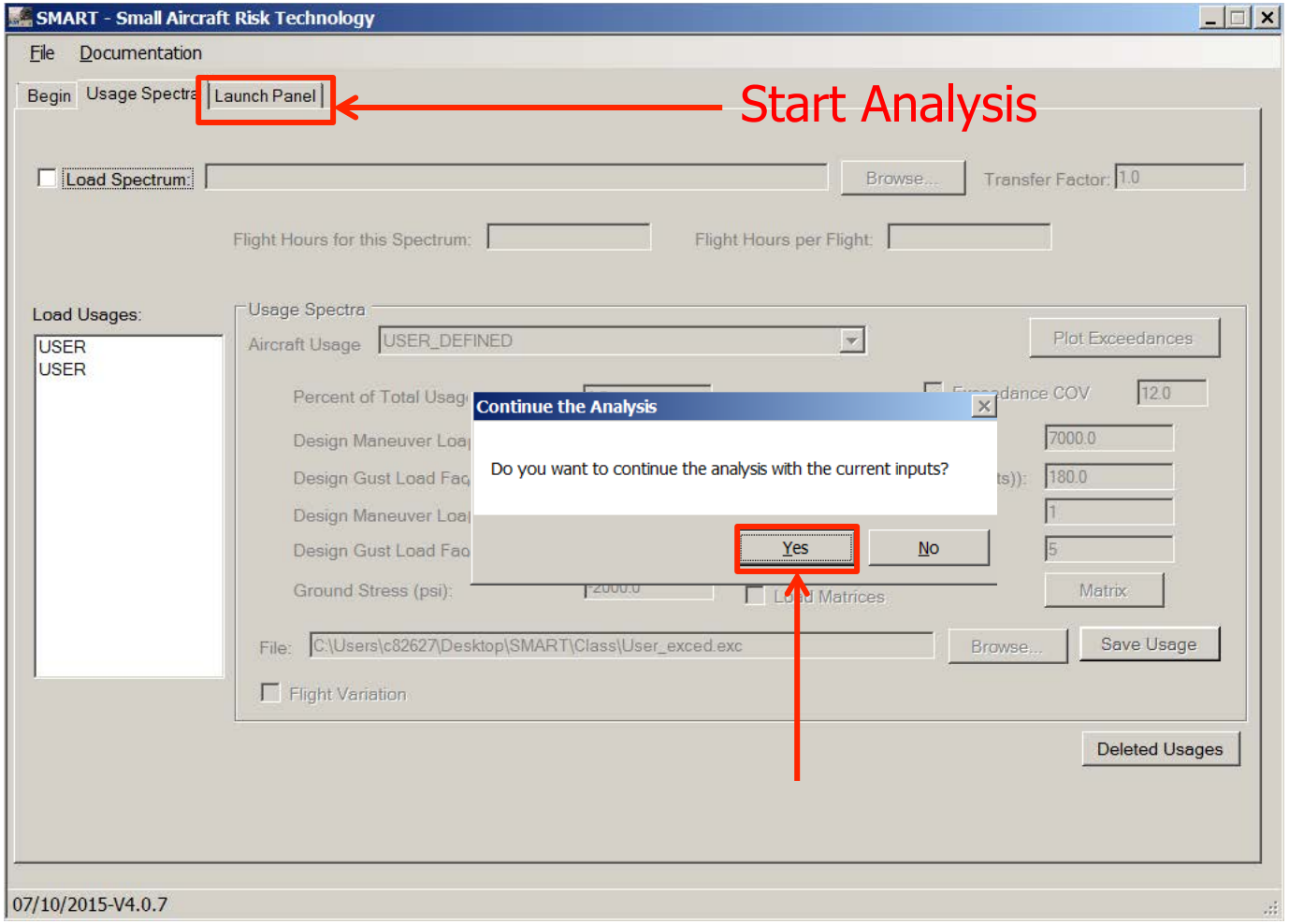
File: C:\Users\c82627\Desktop\SMART\Class\User_exced.exc Browse... Save Usage

Flight Variation

Deleted Usages

07/10/2015-V4.0.7

Launch Analysis



Launch Analysis

SMART - Small Aircraft Risk Technology

File Documentation

Begin | Usage Spectra | Launch Panel

```
! ------------------------------------------------------------
!                    AIRCRAFT INFORMATION
! ------------------------------------------------------------
TITLE = Wing_Spar2
AC_MAKE = Acme
AC_MODEL = Sky
AC_SERIAL_NUM = SR100
AC_TCDS = TCSR100
! ------------------------------------------------------------
!                  SN-CURVE, MINERS AND SSF
! ------------------------------------------------------------
SN_CURVE = PSN_ASTM
MINERS_D = NORMAL 1.0 0.1 0.0
SSF_TYPE = DIRECT
SSF = 3.50
! ------------------------------------------------------------
!                        METHOD
! ------------------------------------------------------------
MCSAMP = 20000
SEED = 8955238
INPUT_FILE = NO
ANALYSIS_TYPE = DAMAGE
! ------------------------------------------------------------
!                    LOADING PARAMETERS
```

Input File Text

Run

07/10/2015-V4.0.7

Review Output

SMART - Small Aircraft Risk Technology

File Documentation

Results

Load Output File: C:\Users\Desktop\SMART\Class\User_example3.txt Load Output

Scatter Plots: Flights to Failure VS Flight Duration Plot

2-D Line: Hours to Failure VS Hazard Function Plot

Histograms: Flight Duration Plot

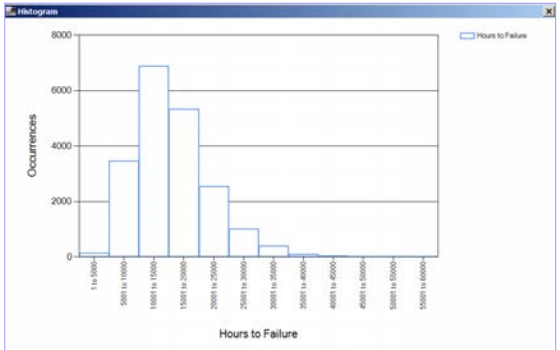
Damage Pie Chart: Plot

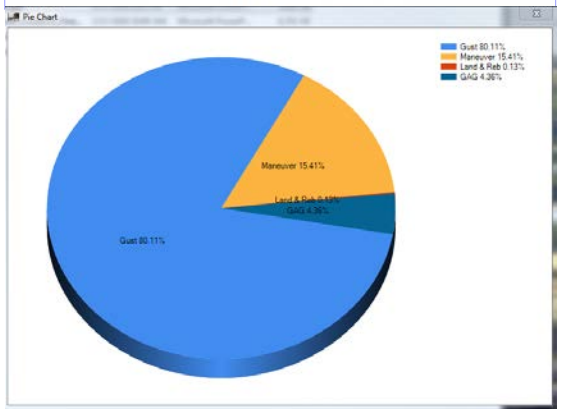
Samples | Output | Screen out | Fleet Management

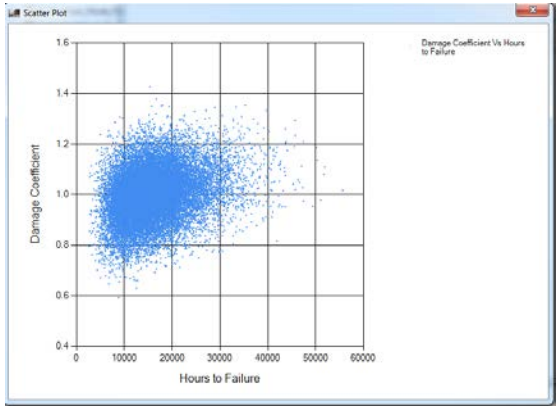
```
                    *SMART ANALYSIS*
 DATE:  2/25/2016
 TIME: 12:37:16
-------------------------------------------------
Job Title: WING_SPAR2
-------------------------------------------------
 SEED:      105769407
 SEED:     1810198165
 SAMPLES:       20000
 SN_CURVE_TYPE: PSN_ASTM
 ANALYSIS_TYPE: DAMAGE
 USER_SPECTRUM: NO
 Airplane Data

              AC_MAKE: ACME
```

07/10/2015-V4.0.7







Summary File

Input Data

```
                    *SMART ANALYSIS*
 DATE:  3/17/2016
 TIME: 15:37:31
--------------------------------------------------
Job Title: WING_SPAR2
--------------------------------------------------
 Airplane Data

               AC_MAKE: ACME
               AC_MODEL: SKY
               AC_SERIAL_NUMBER: SR100
               AC_TCDS: TCSR100
--------------------------------------------------
 User Spectrum: NO
--------------------------------------------------
Summary of Input Data

Flight Variation =              NO
--------------------------------------------------
Analysis Type =                 DAMAGE
--------------------------------------------------
Number of Usages =          2
--------------------------------------------------
Numb. of MC Samples: =            20000
Seed:                           8955238
--------------------------------------------------
Usage:            1
Usage name =   USER_DEFINED
Percentage Usage =  0.50
--------------------------------------------------
Stresses
Ground Stress:                 -2000.00
One g Stress:                   6500.00
--------------------------------------------------
Design Load Limit Factors
Positive Gust:                    3.400
Negative Gust:                   -1.400
Positive Man:                     3.800
Negative Man                     -1.500
--------------------------------------------------
Flt Velocity and Duration Data
```

Data Removed

Output Data

SMART RESULTS

Probability	Flights-to-Failure	Hours-to-Failure
0.500000	30322	15161
0.100000	18063	9031
0.010000	11200	5600
0.001000	7313	3656
0.000223	5550	2775

Mean Results

Lower Bound 90%	Lower Bound 95%	99%	F-T-F Mean	Upper Bound 90%	Upper Bound 95%	99%
32005.	31977.	31923.	32148.	32292.	32320.	32373.

Lower Bound 90%	Lower Bound 95%	99%	H-T-F Mean	Upper Bound 90%	Upper Bound 95%	99%
16002.	15988.	15962.	16074.	16146.	16160.	16187.

Stdev Results

Lower Bound 90%	Lower Bound 95%	99%	F-T-F Stdev	Upper Bound 90%	Upper Bound 95%	99%
12283.	12264.	12227.	12384.	12487.	12507.	12546.

Lower Bound 90%	Lower Bound 95%	99%	H-T-F Stdev	Upper Bound 90%	Upper Bound 95%	99%
6142.	6132.	6113.	6192.	6244.	6253.	6273.

**** PEARSON CORRELATIONS ****

	Flight Duration	A/C Velocity	Sink Rate	Damage Coefficient	Gust Factor	Man Factor	One-g Stress	Ground Stress	PSN
FTF	0.00000	-0.29777	-0.00823	0.27152	-0.65853	-0.22173	-0.41438	0.18266	0.32882
HTF	0.00000	-0.29777	-0.00823	0.27152	-0.65853	-0.22173	-0.41438	0.18266	0.32882

Summary Results per Usage

Review Output

SMART ANALYSIS
DATE: 3/17/2016
TIME: 15:37:31

Job Title: WING_SPAR2

SEED: 105769407
SEED: 1810198165
SAMPLES: 20000
SN_CURVE_TYPE: PSN_ASTM
ANALYSIS_TYPE: DAMAGE
USER_SPECTRUM: NO
Airplane Data

AC_MAKE: ACME
AC_MODEL: SKY
AC_SERIAL_NUMBER: SR100
AC_TCDS: TCSR100

Random Variables and Flights-To-Failure Response

Run	Flight Duration	A/C Velocity	Sink Rate	Damage Coefficient	Gust Factor	Man Factor	One-g Stress	Ground Stress	PSN	Percentage Gust Damage	Percentage Man Damage	Percentage Taxi Damage	Percentage Land & Reb Damage	Percentage GAG Damage	Flights to Failure	Hours to Failure	Hazard Function	Sample Usage
1	0.50	126.0	0.0158	0.7957	3.5876	2.0274	5980.00	-1840.00	-1.9396	0.8920	0.0902	0.000000	0.0003	0.0174	5416	2708.00	0.5270E-06	USER
2	0.50	162.0	1.7371	0.8559	3.2025	1.5818	6110.00	-1880.00	-1.6996	0.8935	0.0873	0.000000	0.0003	0.0188	5473	2736.50	0.5500E-06	USER
3	0.50	144.0	1.7609	1.0702	3.2965	0.9005	6580.00	-1880.00	-1.6130	0.9258	0.0553	0.000000	0.0004	0.0185	5541	2770.50	0.5778E-06	USER
4	0.50	144.0					00	-1880.00	1.4288	0.9323					73		0.5816E-06	USER
5	0.50	162.0					00	-1880.00	-1.1278	0.9575					72		0.6443E-06	USER
6	0.50	162.0					00	-1760.00	-1.9292	0.9433					96		0.7995E-06	USER
7	0.50	162.0					00	-1880.00	-1.6229	0.8954					01		0.8500E-06	USER
8	0.50	144.0					00	-1760.00	-0.7994	0.9631					63		0.9033E-06	USER
9	0.50	144.0					00	-1840.00	1.8182	0.9684					01		0.9213E-06	USER
10	0.50	162.0	1.2505	0.9330	2.8375	0.8895	6440.00	-1840.00	-1.2307	0.9081	0.0723	0.000000	0.0004	0.0192			0.9309E-06	USER
11	0.50	162.0	0.7057	1.0746	3.8294	-0.6852	5980.00	-1840.00	2.4948	0.9700	0.0150	0.000000	0.0001	0.0148			0.9864E-06	USER
12	0.50	162.0	1.6116	0.7627	2.6476	1.4110	6440.00	-1840.00	1.5134	0.8762	0.1026	0.000000	0.0003	0.0209			0.1050E-05	USER
13	0.50	162.0	1.2084	0.8877	2.8285	-1.0854	6300.00	-1800.00	-1.9994	0.9513	0.0285	0.000000	0.0004	0.0198			0.1093E-05	USER
14	0.50	144.0	1.4242	0.8856	3.5842	-0.3212	5980.00	-1840.00	1.1448	0.9593	0.0229	0.000000	0.0002	0.0176			0.1134E-05	USER
15	0.50	162.0	0.8818	0.9816	2.7831	1.1434	6440.00	-1840.00	-1.2055	0.8951	0.0854	0.000000	0.0004	0.0191			0.1192E-05	USER
16	0.50	144.0	3.4824	0.8558	2.7294	0.7568	6440.00	-1840.00	-1.4784	0.9033	0.0716	0.000000	0.0006	0.0245			0.1217E-05	USER
17	0.50	162.0	2.2505	0.8029	2.7356	-0.8665	6110.00	-1880.00	-1.6535	0.9441	0.0331	0.000000	0.0005	0.0223			0.1533E-05	USER
18	0.50	162.0	2.5815	0.8855	2.7737	0.7430	6440.00	-1840.00	1.4405	0.9125	0.0658	0.000000	0.0003	0.0213	7281	3640.50	0.1559E-05	USER
19	0.50	144.0	2.3619	0.8656	2.2040	2.0763	6440.00	-1840.00	-2.8961	0.7858	0.1876	0.000000	0.0007	0.0259	7300	3650.00	0.1575E-05	USER
20	0.50	144.0	2.3287	1.0211	2.9594	1.1466	6440.00	-1840.00	-0.8636	0.9018	0.0768	0.000000	0.0004	0.0209	7313	3656.50	0.1587E-05	USER
21	0.50	162.0	1.6878	0.9352	2.6655	-0.0909	6300.00	-1800.00	-1.9302	0.9287	0.0494	0.000000	0.0005	0.0213	7517	3758.50	0.1778E-05	USER
22	0.50	162.0	0.5268	1.0817	2.5967	-0.4619	6580.00	-1880.00	-2.1466	0.9360	0.0428	0.000000	0.0005	0.0208	7553	3776.50	0.1814E-05	USER

Input Variables

Percent Damage

Flights/ Hours - Failure

Detailed output per MC Run

Safe-Life Results

Probability	Flights-to-Failure	Hours-to-Failure
0.500000	30322	15161
0.100000	18063	9031
0.010000	11200	5600
0.001000	7313	3656
0.000223	5550	2775

Mean Results

Lower Bound				Upper Bound		
90%	95%	99%	F-T-F Mean	90%	95%	99%
32005.	31977.	31923.	32148.	32292.	32320.	32373.

Lower Bound				Upper Bound		
90%	95%	99%	H-T-F Mean	90%	95%	99%
16002.	15988.	15962.	16074.	16146.	16160.	16187.

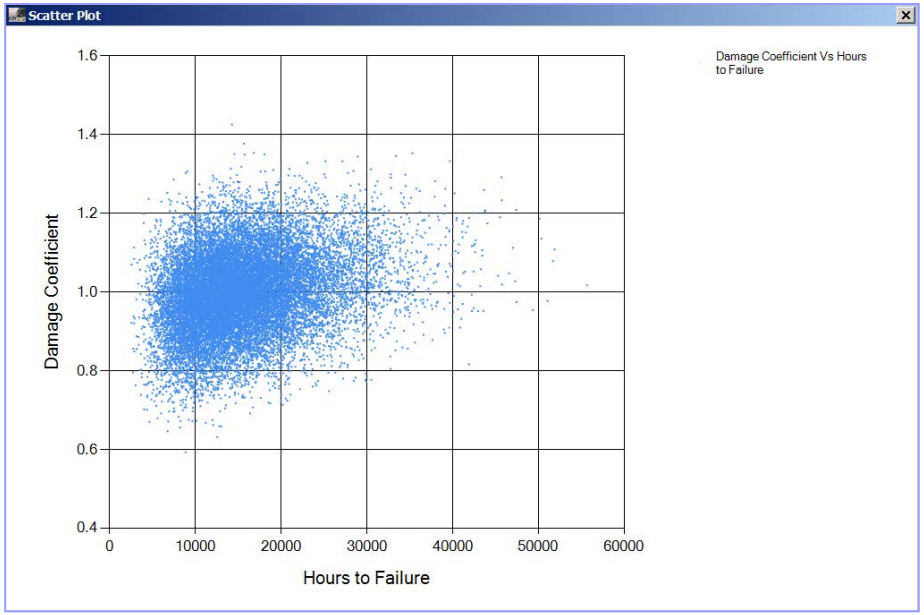
Stdev Results

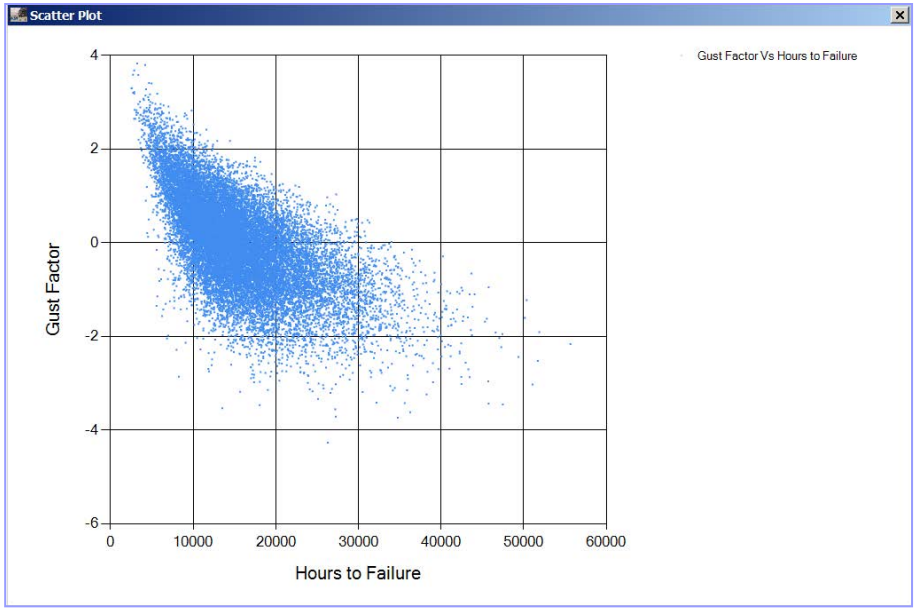
Lower Bound				Upper Bound		
90%	95%	99%	F-T-F Stdev	90%	95%	99%
12283.	12264.	12227.	12384.	12487.	12507.	12546.

Lower Bound				Upper Bound		
90%	95%	99%	H-T-F Stdev	90%	95%	99%
6142.	6132.	6113.	6192.	6244.	6253.	6273.

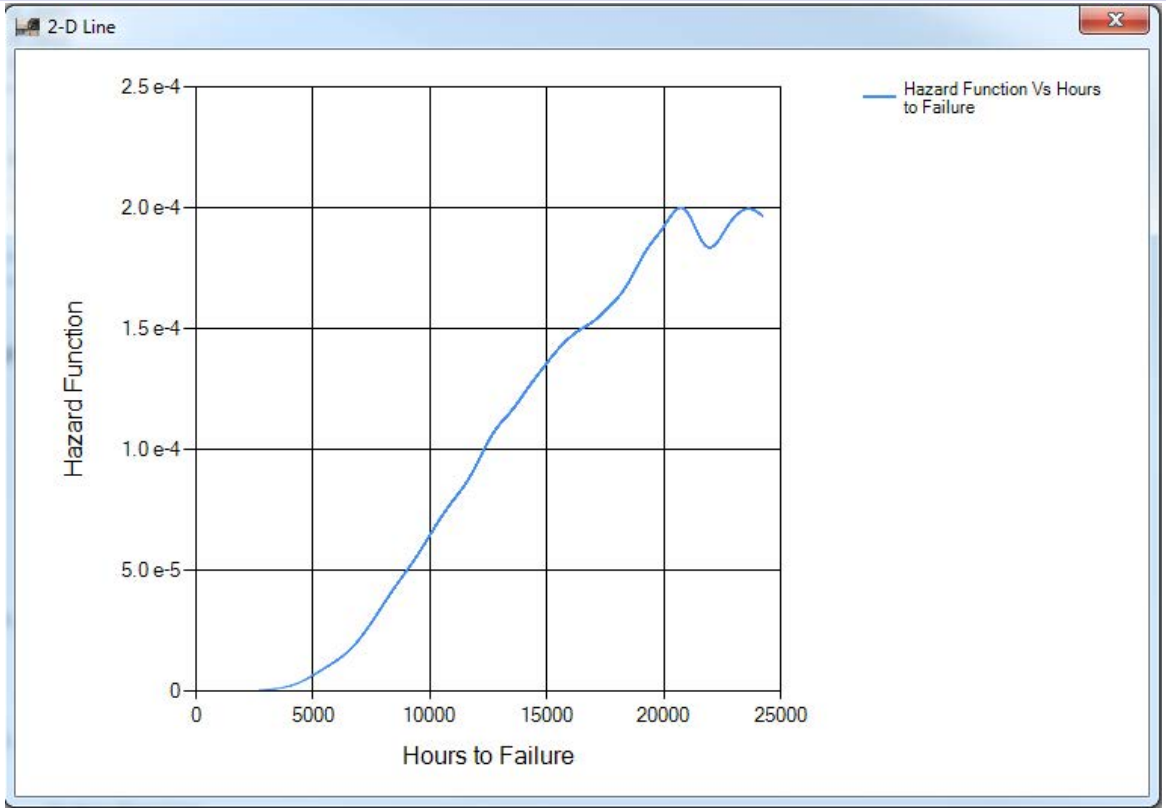
Correlation Sensitivity Analysis

	Flight Duration	A/C Velocity	Sink Rate	Damage Coefficient	Gust Factor	Man Factor	One-g Stress	Ground Stress	PSN
FTF	0.00000	-0.29777	-0.00823	0.27152	-0.65853	-0.22173	-0.41438	0.18266	0.32882
HTF	0.00000	-0.29777	-0.00823	0.27152	-0.65853	-0.22173	-0.41438	0.18266	0.32882





Hazard Function

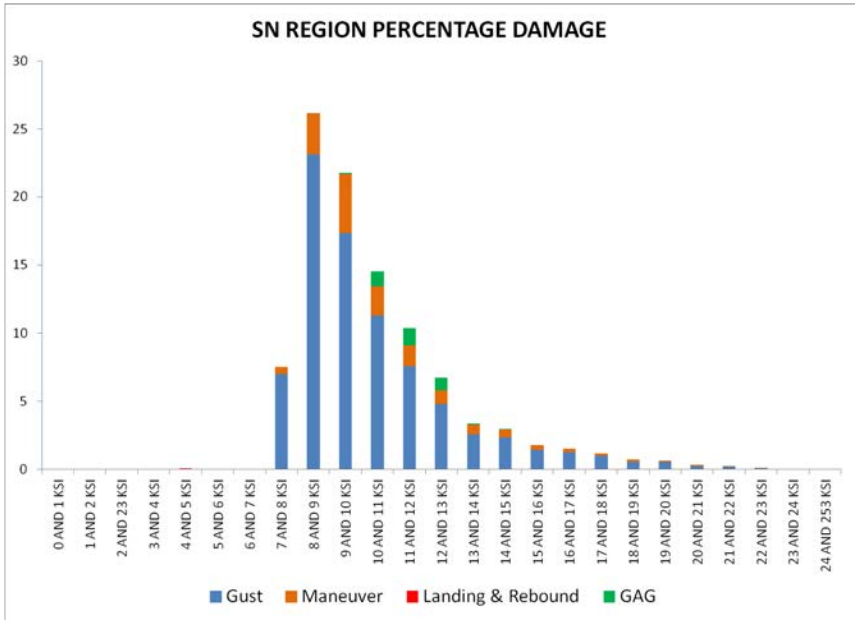


The hazard rate is defined as the probability per time unit that a case that has survived to the beginning of the respective interval will fail in that interval

$$hz(t) = \frac{PDF(t)}{1 - CDF(t)}$$

PSN Region Accumulated Damage

SN REGION	TOTAL	GUST	MAN.	TAXI	Land&Reb.	GAG
BELOW 1 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 1 AND 2 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 2 AND 3 KSI:	0.01	0.00	0.00	0.00	0.01	0.00
BETWEEN 3 AND 4 KSI:	0.04	0.00	0.00	0.00	0.04	0.00
BETWEEN 4 AND 5 KSI:	0.07	0.00	0.00	0.00	0.07	0.00
BETWEEN 5 AND 6 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 6 AND 7 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 7 AND 8 KSI:	10.89	10.21	0.68	0.00	0.00	0.00
BETWEEN 8 AND 9 KSI:	28.84	24.73	4.11	0.00	0.00	0.00
BETWEEN 9 AND 10 KSI:	18.90	15.21	3.59	0.00	0.00	0.10
BETWEEN 10 AND 11 KSI:	14.91	11.04	2.02	0.00	0.00	1.86
BETWEEN 11 AND 12 KSI:	9.96	6.50	1.55	0.00	0.00	1.91
BETWEEN 12 AND 13 KSI:	4.87	3.81	0.86	0.00	0.00	0.20
BETWEEN 13 AND 14 KSI:	3.33	2.70	0.63	0.00	0.00	0.01
BETWEEN 14 AND 15 KSI:	2.52	2.07	0.44	0.00	0.00	0.00
BETWEEN 15 AND 16 KSI:	1.62	1.27	0.36	0.00	0.00	0.00
BETWEEN 16 AND 17 KSI:	1.36	1.10	0.26	0.00	0.00	0.00
BETWEEN 17 AND 18 KSI:	1.00	0.85	0.15	0.00	0.00	0.00
BETWEEN 18 AND 19 KSI:	0.65	0.49	0.15	0.00	0.00	0.00
BETWEEN 19 AND 20 KSI:	0.52	0.44	0.08	0.00	0.00	0.00
BETWEEN 20 AND 21 KSI:	0.30	0.25	0.06	0.00	0.00	0.00
BETWEEN 21 AND 22 KSI:	0.15	0.11	0.04	0.00	0.00	0.00
BETWEEN 22 AND 23 KSI:	0.05	0.01	0.03	0.00	0.00	0.00
BETWEEN 23 AND 24 KSI:	0.01	0.00	0.01	0.00	0.00	0.00
BETWEEN 24 AND 25 KSI:	0.01	0.00	0.01	0.00	0.00	0.00
BETWEEN 25 AND 26 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 26 AND 27 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 27 AND 28 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 28 AND 29 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 29 AND 30 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 30 AND 31 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 31 AND 32 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 32 AND 33 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 33 AND 34 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 34 AND 35 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 35 AND 36 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 36 AND 37 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 37 AND 38 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 38 AND 39 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
BETWEEN 39 AND 40 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
ABOVE 40 KSI:	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL STAGE PERCENTAGE	100.00	80.80	15.01	0.00	0.12	4.07



Questions