

# 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

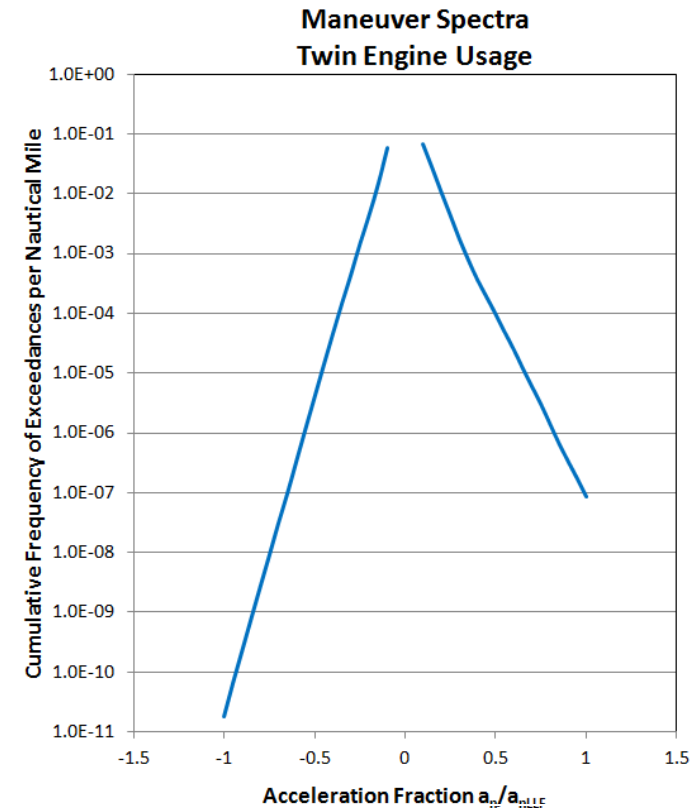
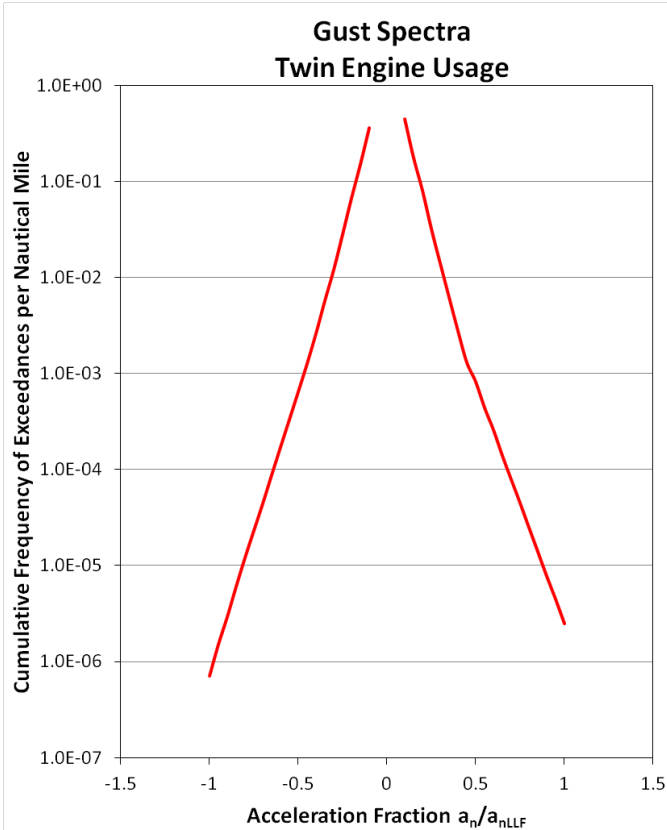
# Problem Overview



<b>Input Parameter</b>	<b>Value</b>
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

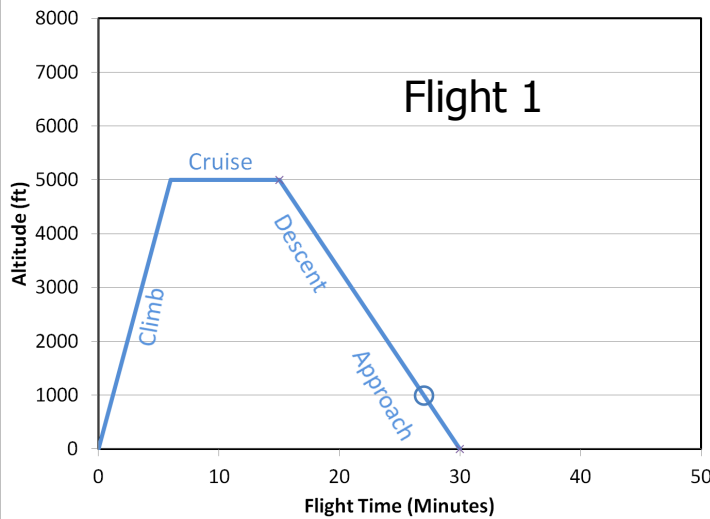
a.f	freq.	inc/nm cov	a.f	freq.	inc/nm cov
0.10	4.45E-01	12	-0.10	3.60E-01	12
0.15	1.75E-01	12	-0.15	1.50E-01	12
0.20	8.00E-02	12	-0.20	6.68E-02	12
0	0	0	0	0	0
0	0	0	0	0	0

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
0	0	0	0	0	0
0	0	0	0	0	0



# 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

$V_C = 200 \text{ KEAS}$

$MTOW = 7000 \text{ lb}$

Sort matrix in ascending order for speed & weight

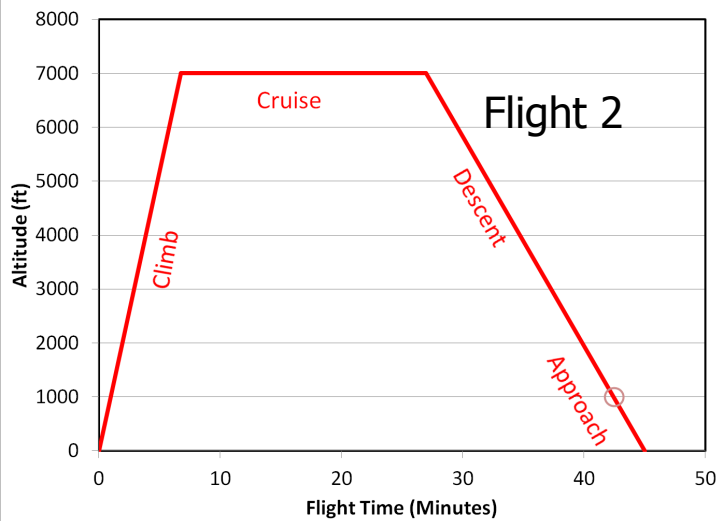
Average Speed During Flight, % Max Takeoff Weight

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

$$V_C = 200 \text{ KEAS}$$

$$\text{MTOW} = 7000 \text{ lb}$$

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<sub>LD</sub> Input




**SMART - Small Aircraft Risk Technology**


File Documentation

Welcome

Welcome to SMART



**SMART<sub>LD</sub>**  
Small Aircraft Risk Technology – Linear Damage



**SMART<sub>DT</sub>**  
Small Aircraft Risk Technology - Damage Tolerance Analysis

**Launch SMART<sub>LD</sub>**

07/10/2015-V4.0.7

# 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:

Load Transfer:

Description:

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

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# 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:

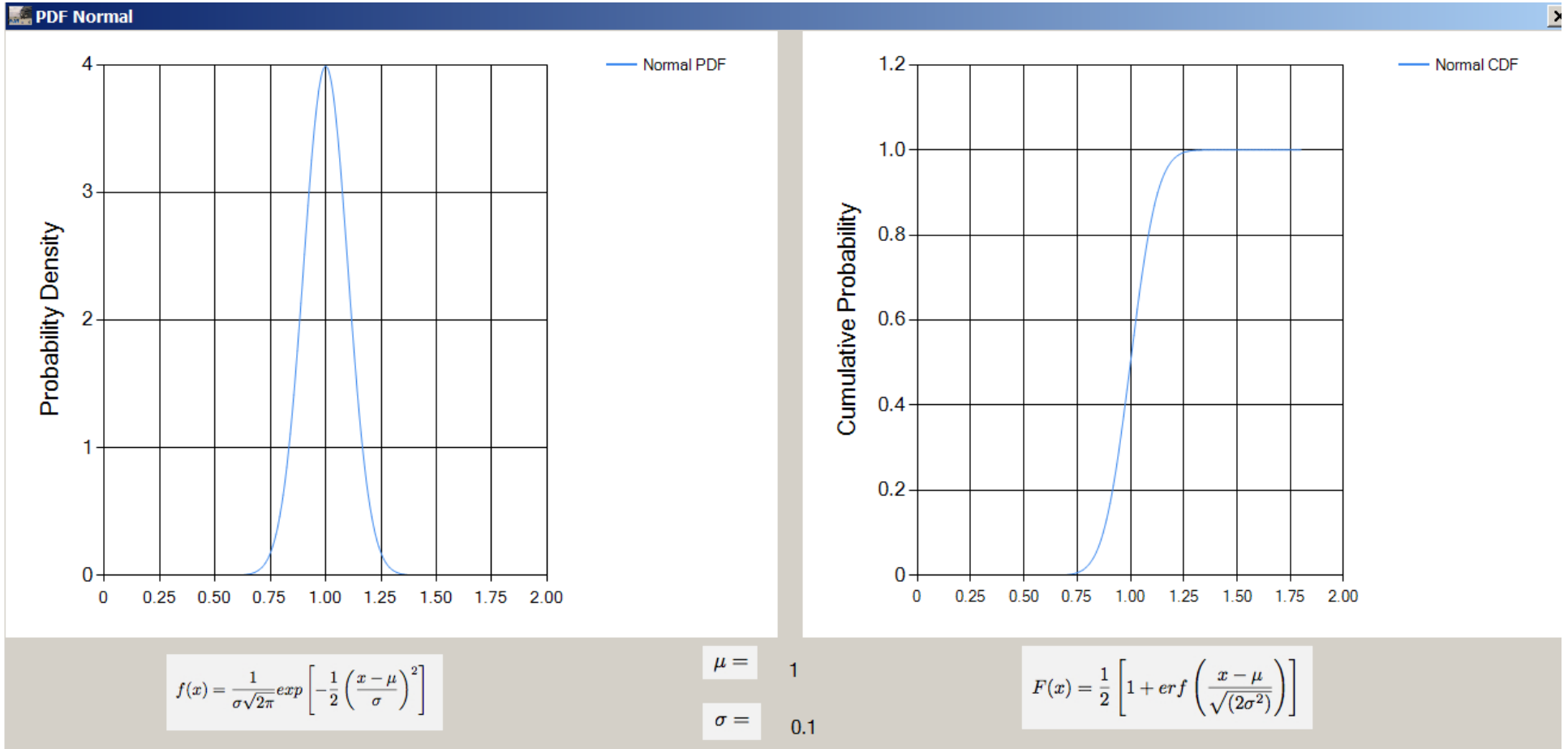
Edge Distance:

Load Transfer:

Plot PDF/CDF

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# Miner's Rule



# SN Curve, SSF



**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: 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

**Log N = A + B(log S)**

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# Analysis Type



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: 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:

Description:

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

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# User Exceedances



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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:

Usage Spectra

Aircraft Usage

Percent of Total Usage:

Design Maneuver Load Factor High:

Design Gust Load Factor High:

Design Maneuver Load Factor Low:

Design Gust Load Factor Low:

Ground Stress (psi):

Exceedance COV

One G Stress (psi):

Average Velocity (Vno/Vmo(Knots)):

Number of Flight Times:

Number of Velocities:

Load Matrices

Matrix

File:  Browse... Save Usage

Flight Variation

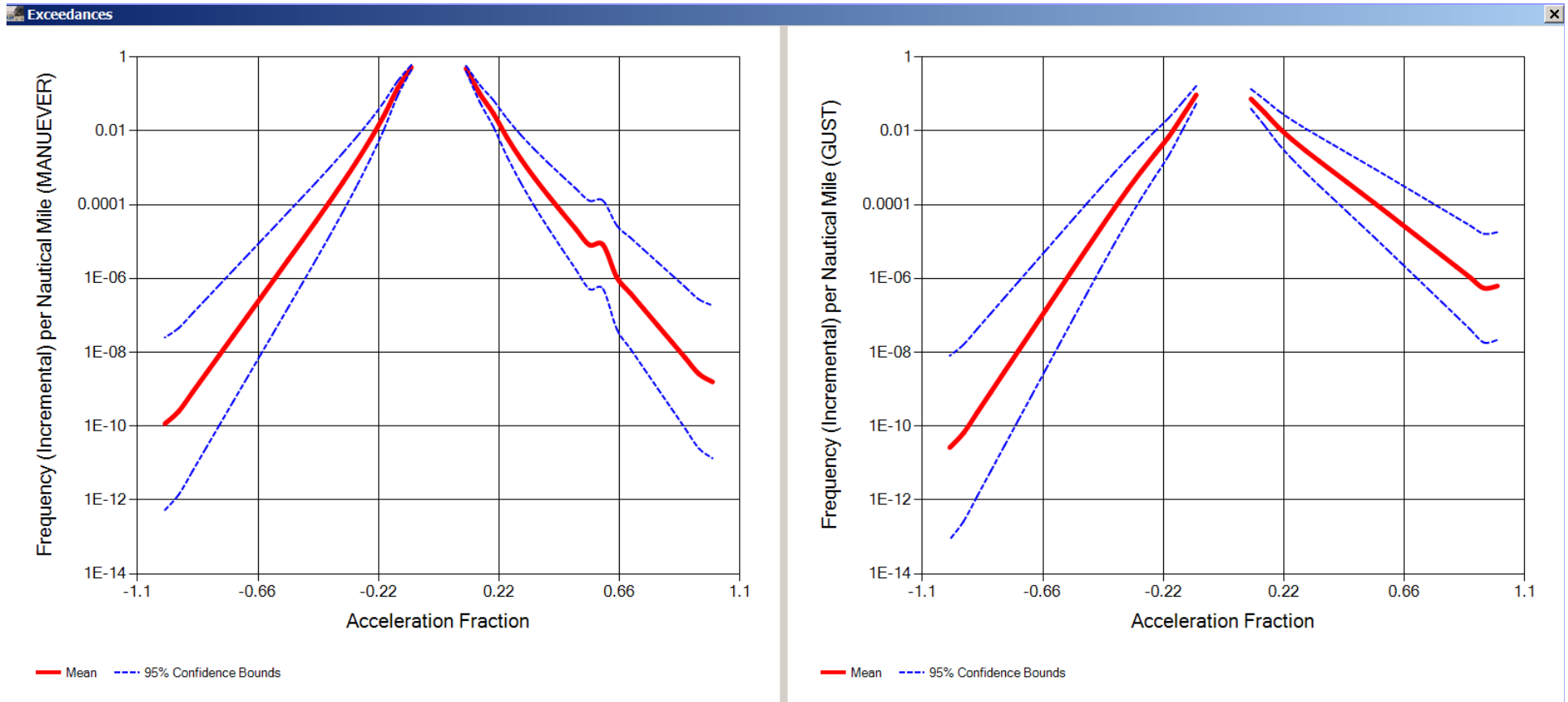
Deleted Usages

Plot Exceedances

Plot Exceedances

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# 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:	<input type="text" value="0.5"/>	<input type="checkbox"/> Exceedance COV	<input type="text" value="12.0"/>
Design Maneuver Load Factor High:	<input type="text" value="3.8"/>	One G Stress (psi):	<input type="text" value="6500.0"/>
Design Gust Load Factor High:	<input type="text" value="3.4"/>	Average Velocity (Vno/Vmo(Knots)):	<input type="text" value="180.0"/>
Design Maneuver Load Factor Low:	<input type="text" value="-1.5"/>	Number of Flight Times:	<input type="text" value="1"/>
Design Gust Load Factor Low:	<input type="text" value="-1.4"/>	Number of Velocities:	<input type="text" value="5"/>
Ground Stress (psi):	<input type="text" value="-2000.0"/>	<input checked="" type="checkbox"/> Load Matrices	<input type="text" value="Matrix"/>

File:  Browse... Save Usage

Flight Variation

Deleted Usages

07/10/2015.V4.0.7

# Flight #1 Matrices



**Matrix** [X]

**Flight Times vs. Velocity**

Flt.Time(hrs)	% of Flts.	%Vno or %Vmo	%Vno or %Vmo	%Vno or %Vmo	%Vno or %Vmo	%Vno or %Vmo
0.50	1.0	0.60	0.70	0.80	0.90	1.00
		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.
0.50	1.0	0.88	0.90	0.92	0.94	0.96
		0.10	0.20	0.50	0.20	0.0

Define weight matrix #1



# 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

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# Define Usage Spectra



Flight 2

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File Documentation

Begin Usage Spectra

Load Spectrum:  Browse... Transfer Factor:

Flight Hours for this Spectrum:  Flight Hours per Flight:

Load Usages:

- USER
- USER

Usage Spectra

Aircraft Usage:  Plot Exceedances

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

File:  Browse... Save Usage

Flight Variation

Deleted Usages

07/10/2015-V4.0.7

# Flight #2 Matrices



**Matrix** [X]

**Flight Times vs. Velocity**

Flt.Time(hrs)	% of Flts.	%Vno or %Vmo	%Vno or %Vmo	%Vno or %Vmo	%Vno or %Vmo	%Vno or %Vmo
0.75	1.0	0.60	0.70	0.80	0.90	1.00
		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.
0.75	1.0	0.88	0.90	0.92	0.94	0.96
		0.00	0.10	0.15	0.60	0.15

Define weight matrix #2

# 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

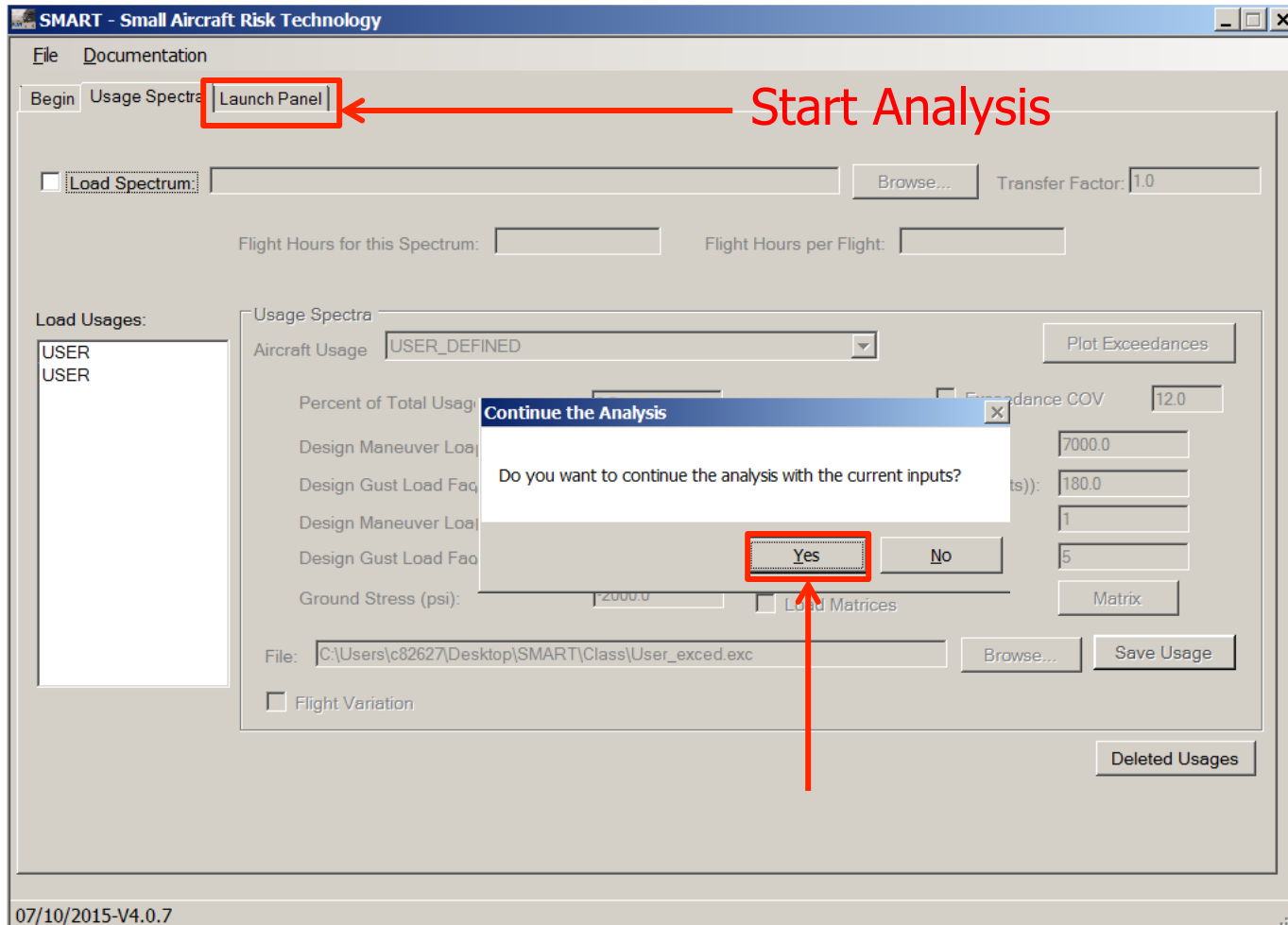
Ground Stress (psi): -2000.0  Load Matrices Matrix

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



**SMART - Small Aircraft Risk Technology**

File Documentation

Begin Usage Spectra **Launch Panel**

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: [ ] Exceedance COV: 12.0

Design Maneuver Load: [7000.0]

Design Gust Load Factor: [180.0]

Design Maneuver Load: [1]

Design Gust Load Factor: [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]

**Continue the Analysis**  
Do you want to continue the analysis with the current inputs?  
Yes No

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# 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**

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# Review Output



**SMART - Small Aircraft Risk Technology**

File Documentation

Results

Load Output File: C:\Users\Desktop\SMART\Class\User\_example3.bt 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

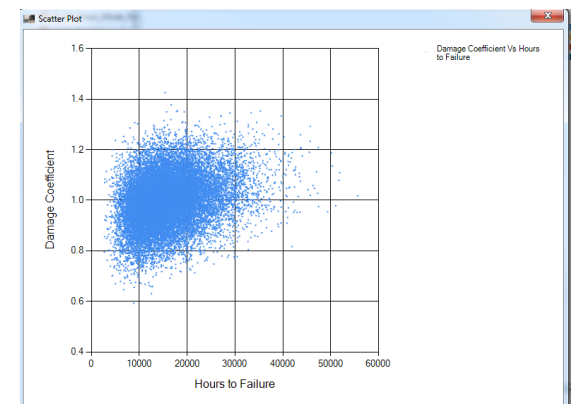
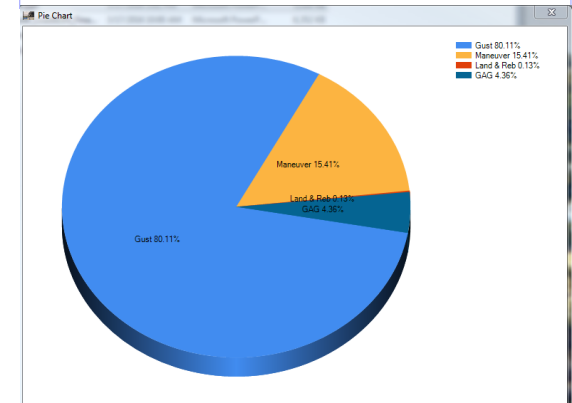
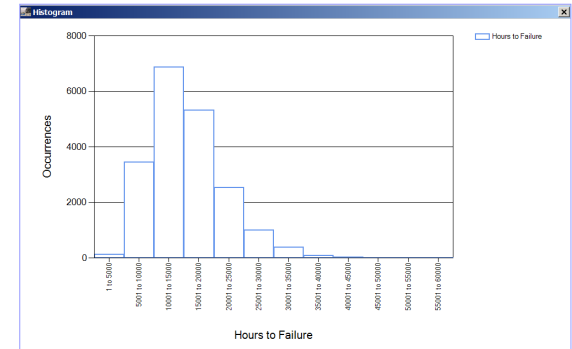
Samples Output Screen out Fleet Management

```

*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





NuSS  
Sustainment  
Solutions

TEXTRON AVIATION

# 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_TCS: 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%   95%   99%   F-T-F Mean   90%   95%   99%
32005.  31977.  31923.  32148.  32292.  32320.  32373.

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

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

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

-----
**** PEARSON CORRELATIONS ****

Flight   A/C   Sink   Damage   Gust   Man   One-g   Ground   PSN
Duration Velocity Rate   Coefficient   Factor   Factor   Stress   Stress
RTF  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





TEXTRON AVIATION

# 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						-1880.00	1.4288	0.9323				0.0173			0.5816E-06	USER
5	0.50	162.0						-1880.00	-1.1278	0.9575				0.0172			0.6443E-06	USER
6	0.50	162.0						-1760.00	-1.9292	0.9433				0.0196			0.7995E-06	USER
7	0.50	162.0						-1880.00	-1.6229	0.8954				0.0101			0.8500E-06	USER
8	0.50	144.0						-1760.00	-0.7994	0.9631				0.0163			0.9033E-06	USER
9	0.50	144.0						-1840.00	1.8182	0.9684				0.0101			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		F-T-F Mean		Upper Bound		
90%	95%	99%		90%	95%	99%
32005.	31977.	31923.	32148.	32292.	32320.	32373.

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

### Stdev Results

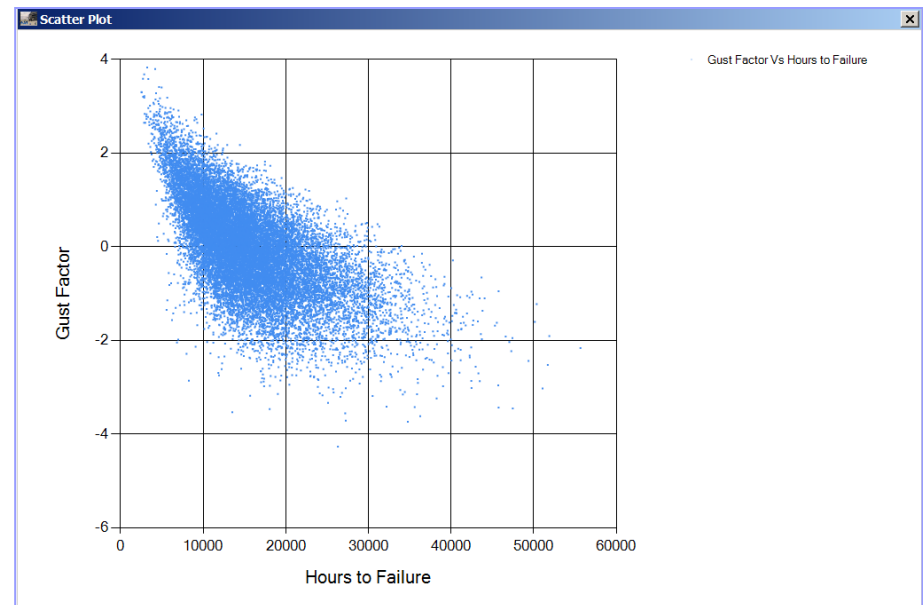
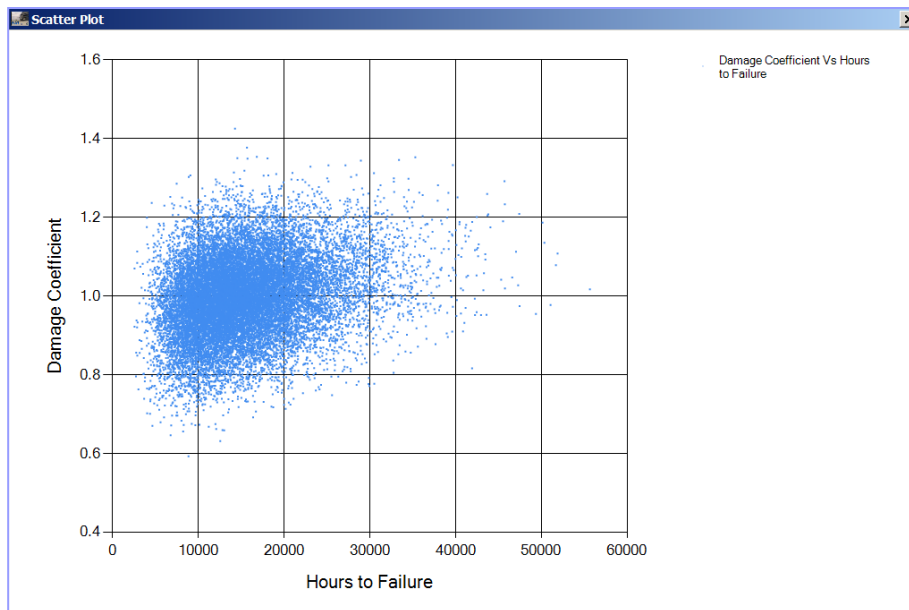
Lower Bound		F-T-F Stdev		Upper Bound		
90%	95%	99%		90%	95%	99%
12283.	12264.	12227.	12384.	12487.	12507.	12546.

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

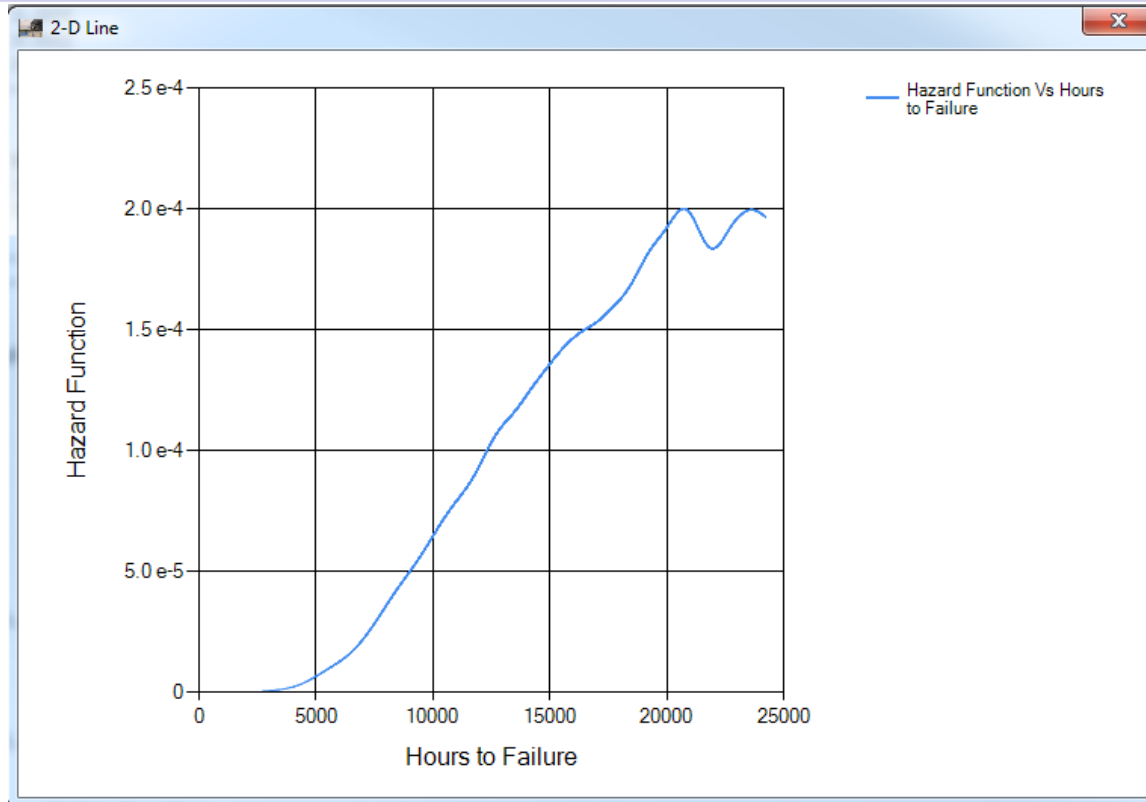
# Correlation Sensitivity Analysis



	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



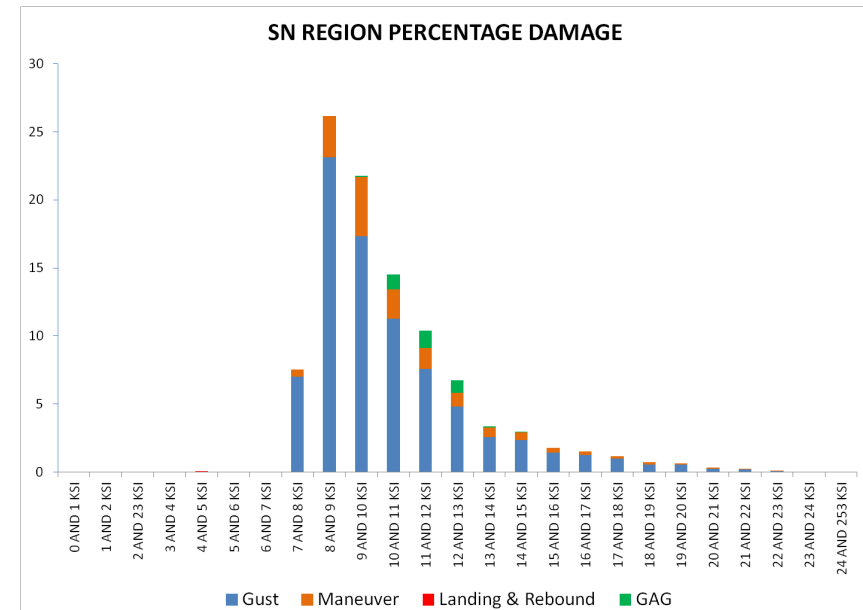
The hazard rate is defined as the probability per time unit that a case that has survived to the beginning of the respective interval will fail in that interval

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

# 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
<b>TOTAL STAGE PERCENTAGE</b>	<b>100.00</b>	<b>80.80</b>	<b>15.01</b>	<b>0.00</b>	<b>0.12</b>	<b>4.07</b>



# Questions

