NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Aviation Engineering Division
Washington, DC 20594

September 2, 2004

ADDENDUM NUMBER 19 TO THE STRUCTURES GROUP CHAIRMAN'S FACTUAL REPORT

DCA02MA001

A. ACCIDENT

Location:	Belle Harbor, NY
Date:	November 12, 2001
Time:	09:16:14 EST
Aircraft:	American Airlines Flight 587, Airbus Model A300-605R, N14053 Manufactures Serial Number (MSN) 420

B. STRUCTURES GROUP

Chairman:	Brian K Murphy National Transportation Safety Board Washington, DC

C. AIRBUS REPORT

1. ***"Flight AA587 Accident Investigation, Influence of the VTP Root Bending/Torsion Ratio of Load CaseW375 Is 18 and CD Analyses on the RHS Rear Main Lug Force"***

AIRBUS	**Technical Note**	

Report Nr.: TN – ESGE – 0004/04

Author:
Department.:

Title

Flight AA587 Accident Investigation

Influence of the VTP Root Bending-/Torsion- Moment Ratio of Load case W375 Is18 and CFD Analyses on the RHS Rear Main Lug Force

Date: 01.09.2004

Summary:

In this report the range of magnitude of the RHS rear main lug forces at rupture are calculated for vertical fin loads defined by the '*Uncertainty Box*' given in [1].

It is shown, that for the range of MxQ/MzQ-ratios the resultant RHS rear main lug force varies between 806.3 kN and 941.4 kN.

The Variation of MzQ for a given MxQ has a very low influence on the lug force.

Public Docket	Issue	Date	No. of page	Revised pages	Valid from/for
	1	01.09.2004	10		

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References

	Report No.	Title
[1]		Aircraft Performance Group Chairman's Aircraft Performance Study, Addendum #2
[2]	TN-ESGC.1018/03	AAL587 Airbus Structure Investigation / Accident Analysis – FEM RHS local rear lug model
[3]	TN-ESGE 0001/04	Validation of Subcomponent Test Principles

1. Introduction

In this report the range of magnitude of the RHS rear main lug forces at rupture are calculated for vertical fin loads defined by the '*Uncertainty Box*' given in [1].
Because no load distribution for the FEM analysis model are available which meet the loads resultants belonging to the corner points A to D of the '*Uncertainty Box*' (fully correlated data to fit fin root loads values at the corner points A to D), the following 2 procedures are applied:

1. the nodal forces from load case W375 Is18 are scaled to the required bending moment at points A to D,
2. CFD results are scaled to the required bending moment at points A to D.

Both procedures are resulting in slightly differing lateral loads Qy. The torsion moment MzQ from case W375 is higher while from the CFD cases MzQ is lower than the required moment at points A to D. The lug forces calculated by FEM from the scaled case W375 and CFD delivers an upper and lower bound for the RHS rear main lug load.

2. MxQ Moment at rupture uncertainty box

The '*Uncertainty Box*' is provided in [1] and is defined by the corner points A to D (see diagram 2.1)

The loads resultants in the component coordinate system are given in table 2.1.

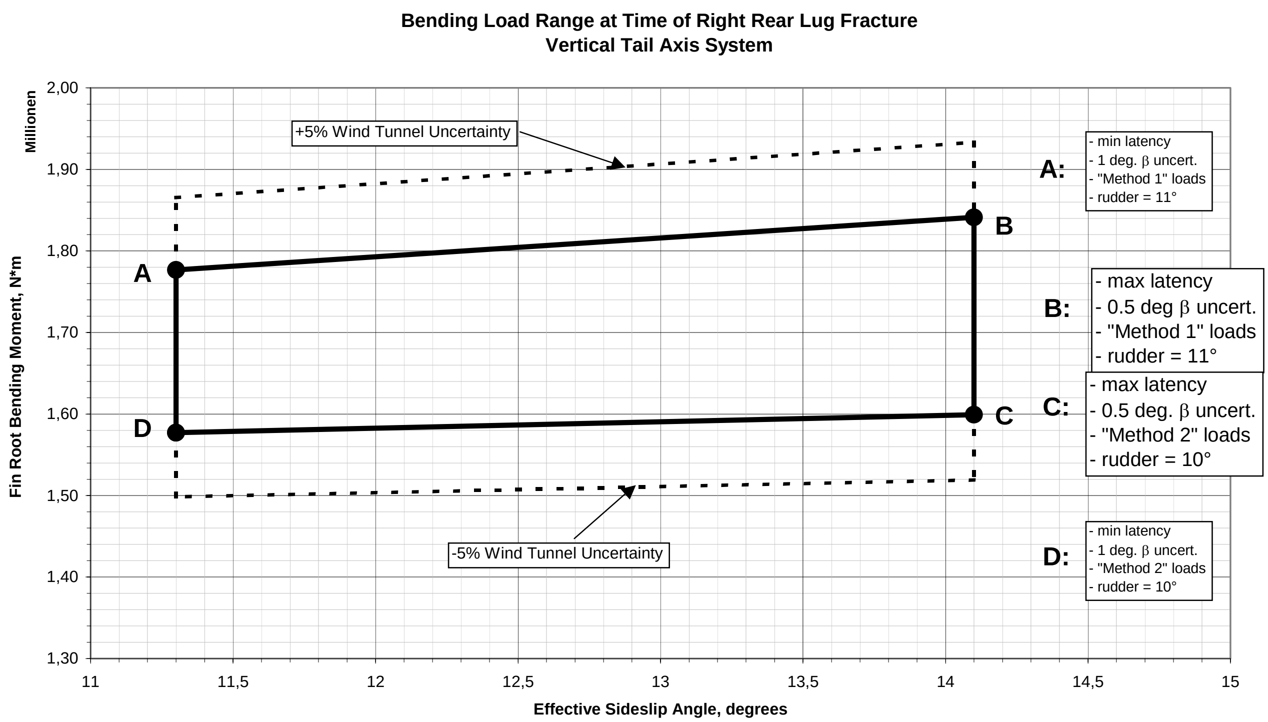

Diagram 2.1

NTSB Fin Root Load Resultant					
Point	Qy	MxQ	MzQ	Beta eff	Rudder Angle
	[N]	[Nm]	[Nm]	[°]	[°]
A	-394 632	1 776 549	38 334	11.3	-11
B	-435 931	1 841 238	48 101	14.1	-11
C	-367 100	1 599 168	18 590	14.1	-10
D	-353 333	1 577 126	28 399	11.3	-10

Table 2.1

3. Scaled load resultants and RHS rear lug forces from load case W375 Is18

The load resultants from the load case W375 Is18 are scaled by the bending moment ratios for corner points A to D (see table 3.1) $MxQ_{A,B,C,D}$ / $MxQ_{W375Is18}$.

Fin Root Load Resultant			
Point	Qy	MxQ	MzQ
	[N]	[Nm]	[Nm]
W375_A	-400 944	1 776 549	91 664
W375_B	-415 543	1 841 238	95 002
W375_C	-360 911	1 599 168	82 512
W375_D	-355 937	1 577 126	81 374

Table 3.1

The corresponding attachment forces (see table 3.2) at the RHS rear main lug are calculated from the results obtained from the NASTRAN VTP FE-Model with the LHS and RHS embedded 3D rear lugs [2].

Rear Main Lug Forces				
Point	Fx	Fy	Fz	Fxz
	[N]	[N]	[N]	[N]
W375_A	-381 648	35 612	-823 439	907 583
W375_B	-395 545	36 909	-853 422	940 630
W375_C	-343 542	32 056	-741 222	816 965
W375_D	-338 807	31 615	-731 005	805 704

Table 3.2

4. Scaled load resultants and RHS rear main lug forces from the CFD a-nalysis

From two CFD analysis with beta,$_{CG}$=11° and 14° with a rudder deflection of 10° the load resultants were scaled to the bending moments of the ‘*Uncertainty Box*’ corner points:

- points A and D: CFD load case D001 with beta,$_{CG}$=11°
- points B and C: CFD load case D005 with beta,$_{CG}$=14°

The scaled load resultants are shown in table 4.1.

Fin Root Load Resultant			
Point	Qy	MxQ	MzQ
	[N]	[Nm]	[Nm]
D001_A	-364 734	1 776 549	10 133
D005_B	-398 761	1 841 238	11 526
D005_C	-346 336	1 599 168	10 010
D001_D	-323 792	1 577 126	8 995

Table 4.1

In addition to the pressure distribution from the CFD analysis, the inertia effect due to the mass distribution is taken into account.

The subsequent structural FEM-analysis with the same FE-models as used in chapter 3 give the RHS rear lug forces shown in table 4.2.

Rear Main Lug Forces				
Point	Fx	Fy	Fz	Fxz
	[N]	[N]	[N]	[N]
D001_A	-400 158	37 071	-822 170	914 380
D005_B	-415 728	38 339	-847 233	943 734
D005_C	-361 072	33 299	-735 846	819 660
D001_D	-355 239	32 910	-729 879	811 738

Table 4.2

5. Conclusion

Figure 5.1 shows the scaled load resultants MxQ/MzQ from the load case W375 Is18 and both CFD results D001 and D005 in comparison with the MxQ/MzQ-values of the '*Uncertainty Box*' corner points A, B, C and D.

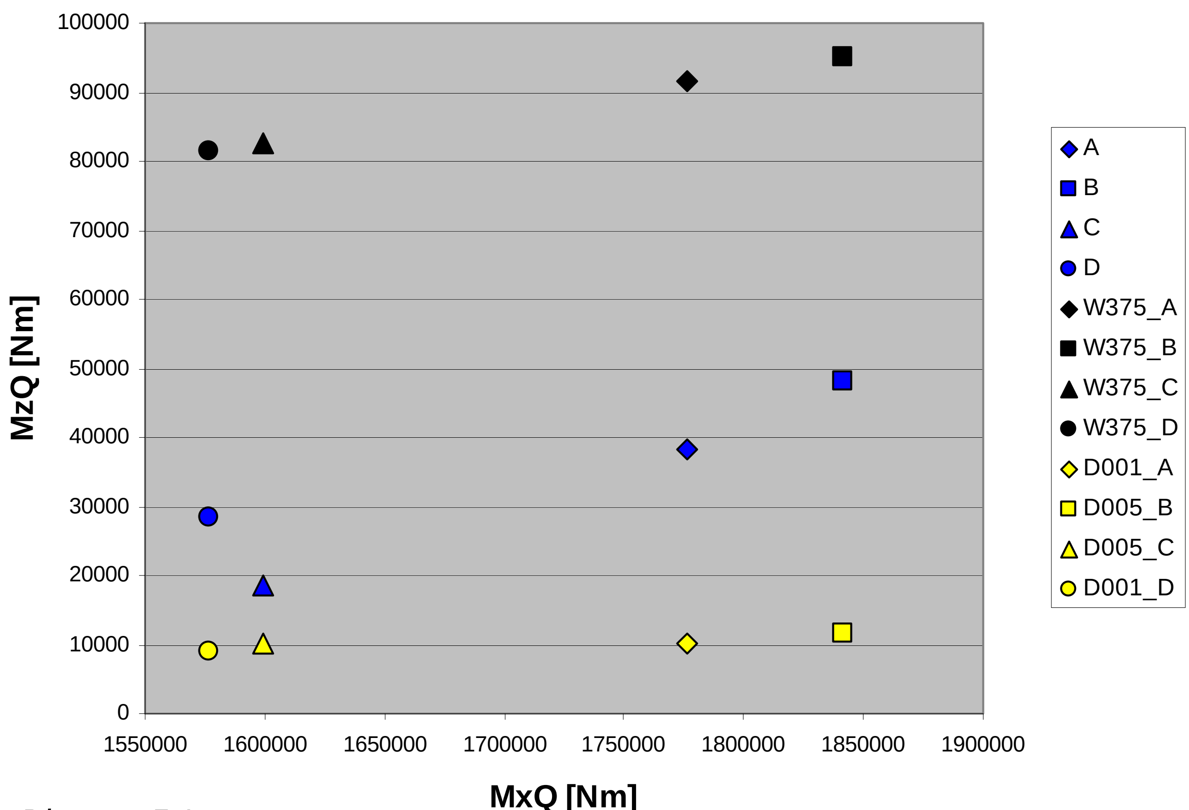

Diagram 5.1

It is visible that for all given bending moments at the points A to D the scaled MzQ-values from case W375 Is18 are higher and for the CFD cases D001/D005 the MzQ-values are lower.

Influence of the VTP Root Bending-/Torsion- Moment Ratio

of Load case W375 ls18 and CFD Analyses on the RHS Rear Main Lug Force

The corresponding Fx, Fz and the resultant Fxz forces are shown over MzQ in figure 5.2 to 5.4 (An extrapolation (eg. for lateral gust case) is not allowed because the lug forces are effected by the load distribution as a result of the static overdeterminated support).

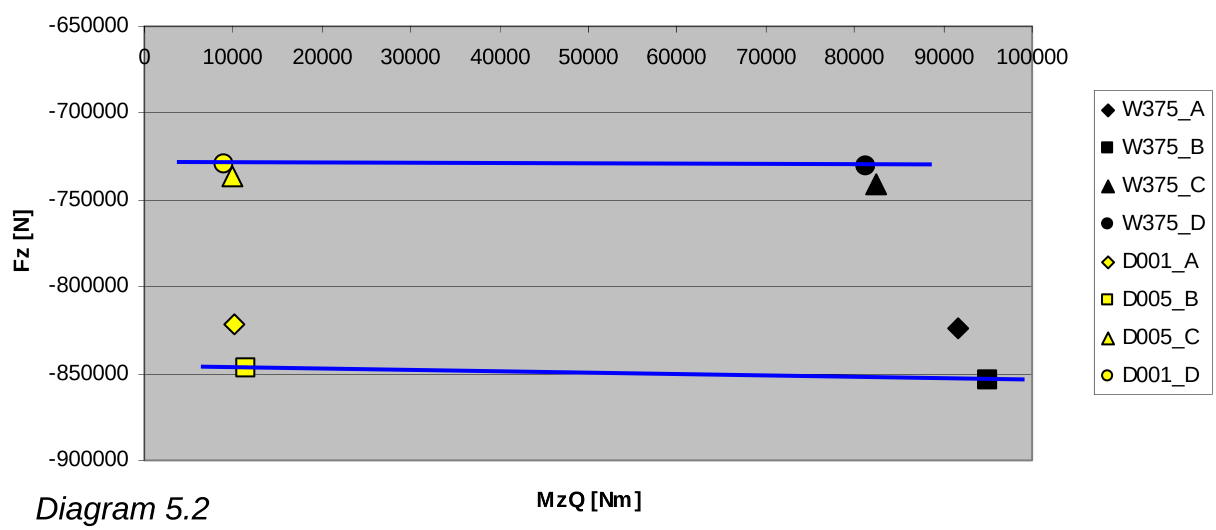

Diagram 5.2

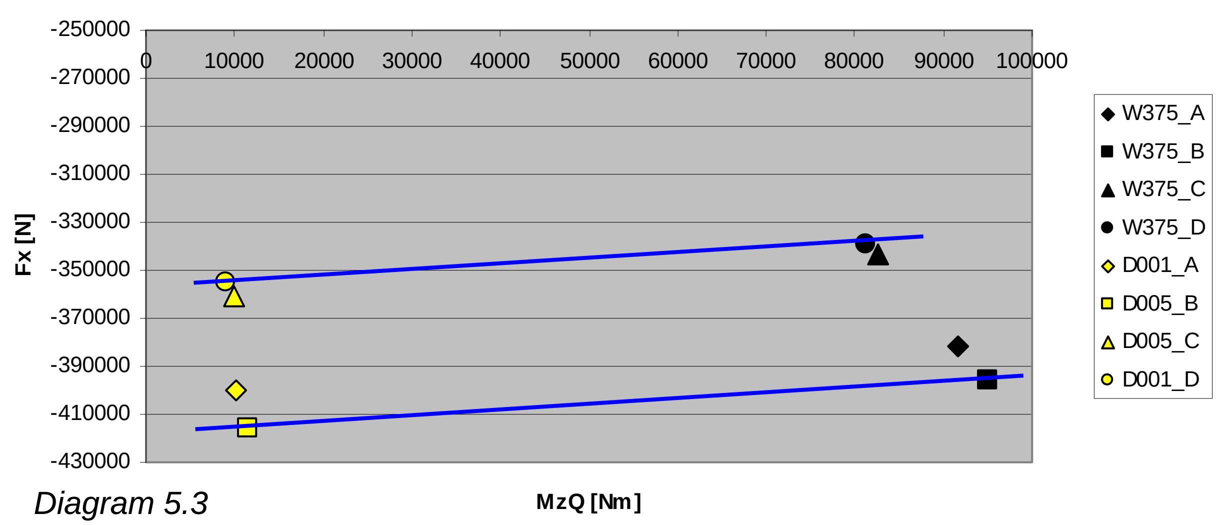

Diagram 5.3

Influence of the VTP Root Bending-/Torsion- Moment Ratio

of Load case W375 ls18 and CFD Analyses on the RHS Rear Main Lug Force

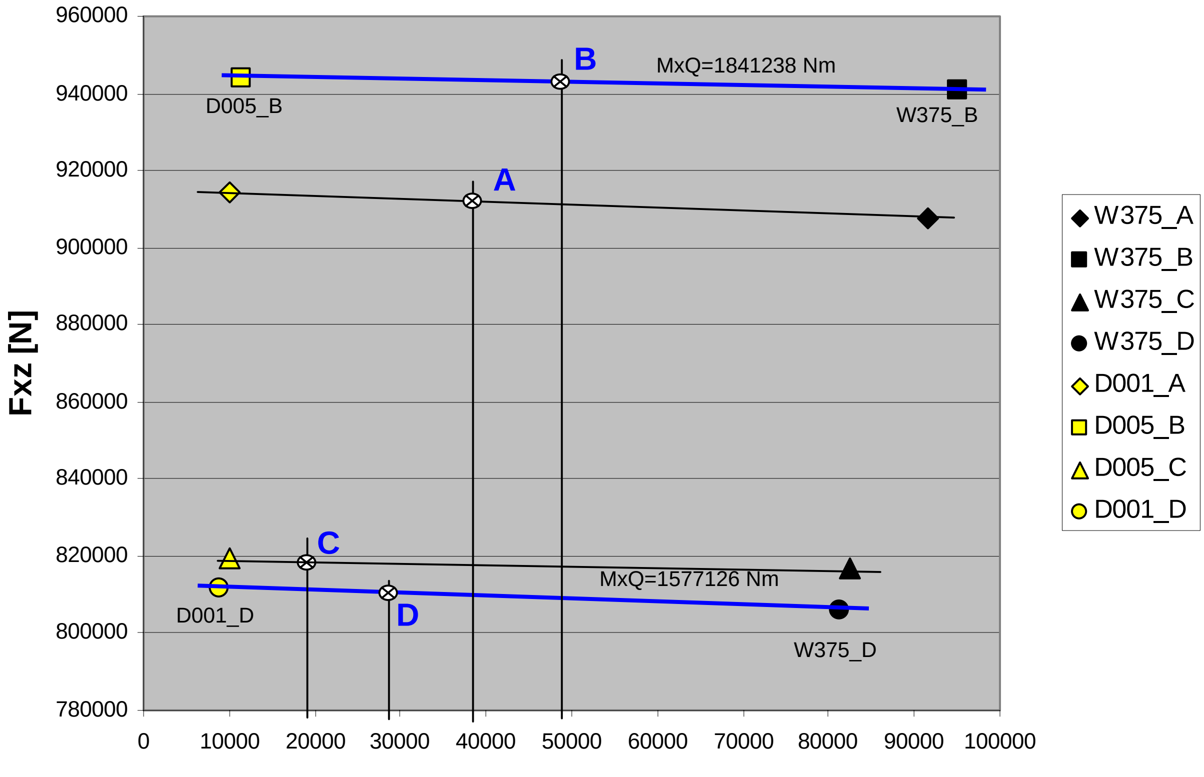

Diagram 5.4

The straight lines passing through W375_B/D005_B is for MxQ=1 841 238 Nm and through W375_D/D001_D is for MxQ=1 577 126 Nm. It is visible from the slope of the MxQ straight lines that a decreasing MzQ with MxQ remaining constant gives a small decrease in Fx and a small increase in Fz.

The force resultant Fxz is mainly driven by the bending moment MxQ and is very little effected by the torsion moment MzQ.

The range of the RHS rear main lug resultant Fxz for the '*Uncertainty Box*' corner points A to D can be derived from interpolation from diagram 5.4. Fxz varies between 943 734 N (point D005_B) and 805 704 N, point W375_D. In the interval of MzQ the variation of Fxz for a constant Moment MxQ is below 1%.

The variation of the circumferential strains at the locations E01o to E09o [3] for the scaled cases W375_D and D005_B are shown on diagram 5.5 with the measured values of Lug Test#2 included.

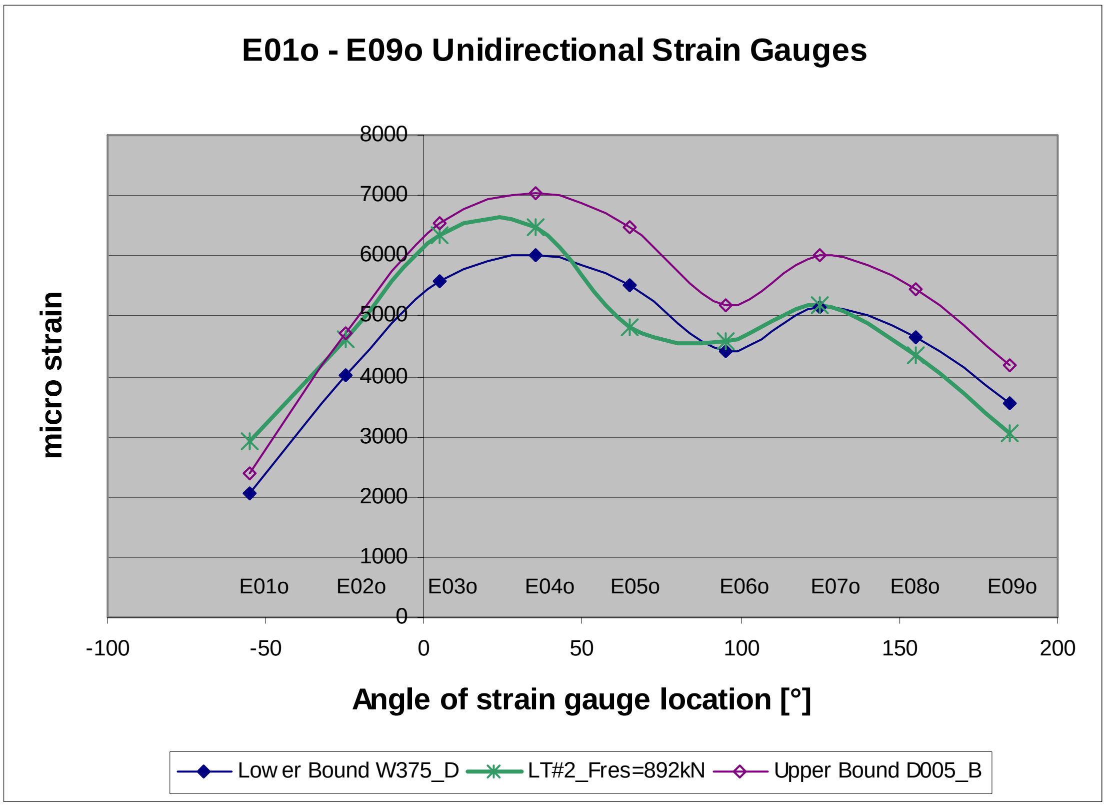

Diagram 5.5

Fig. 5.5 demonstrates that the peak strain values from the test lies inside the calculated strain boundaries belonging to points B and D.