NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

January 30, 2015

Group Chairman's Factual Report

STRUCTURES

DCA13RA081

Attachment 12

Telair Study Cougar
Vehicle Restraint Analysis (with tie down straps)
June 3, 2014

All the Pieces For Complete Cargo Competence ™

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Cougar Vehicle Restraint Analysis (with tiedown straps)

B747-428 (BCF)

Registration: N949CA
MSN 25630

29-Apr-2013, Bagram (Afghanistan)

Tall Rigid Cargo Requirement

- Centerline loaded cargo must be aft of B.A. 1220.
- There must be a minimum of the equivalent of seven 125 inch long loaded unit load devices positioned directly forward of the rigid cargo greater than 96 inches.
- It is not possible to safely and properly secure a Cougar vehicle in any location.
- FWD of tall rigid cargo there is no access to sufficient tiedown points, because this area must be occupied with other frangible cargo.
- The following tiedown schemes violate the tall rigid cargo requirements, and have been performed only for NTSB investigation support at the NTSB's request.

Tiedown Straps for one Cougar
(B.A. 1161.2 – 1399.7, 18646 kg, CG at B.A. 1280.5)

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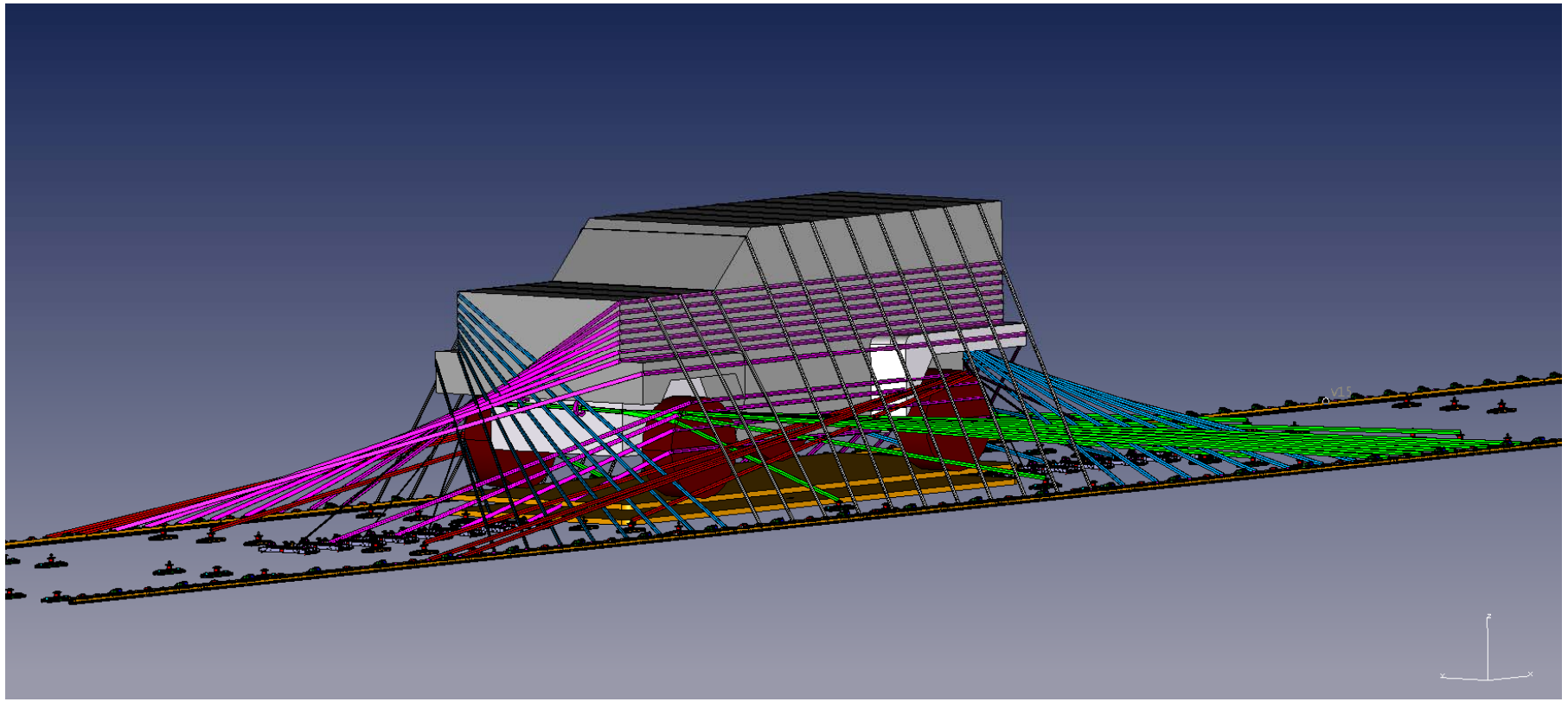


13.2.2. Load Factors

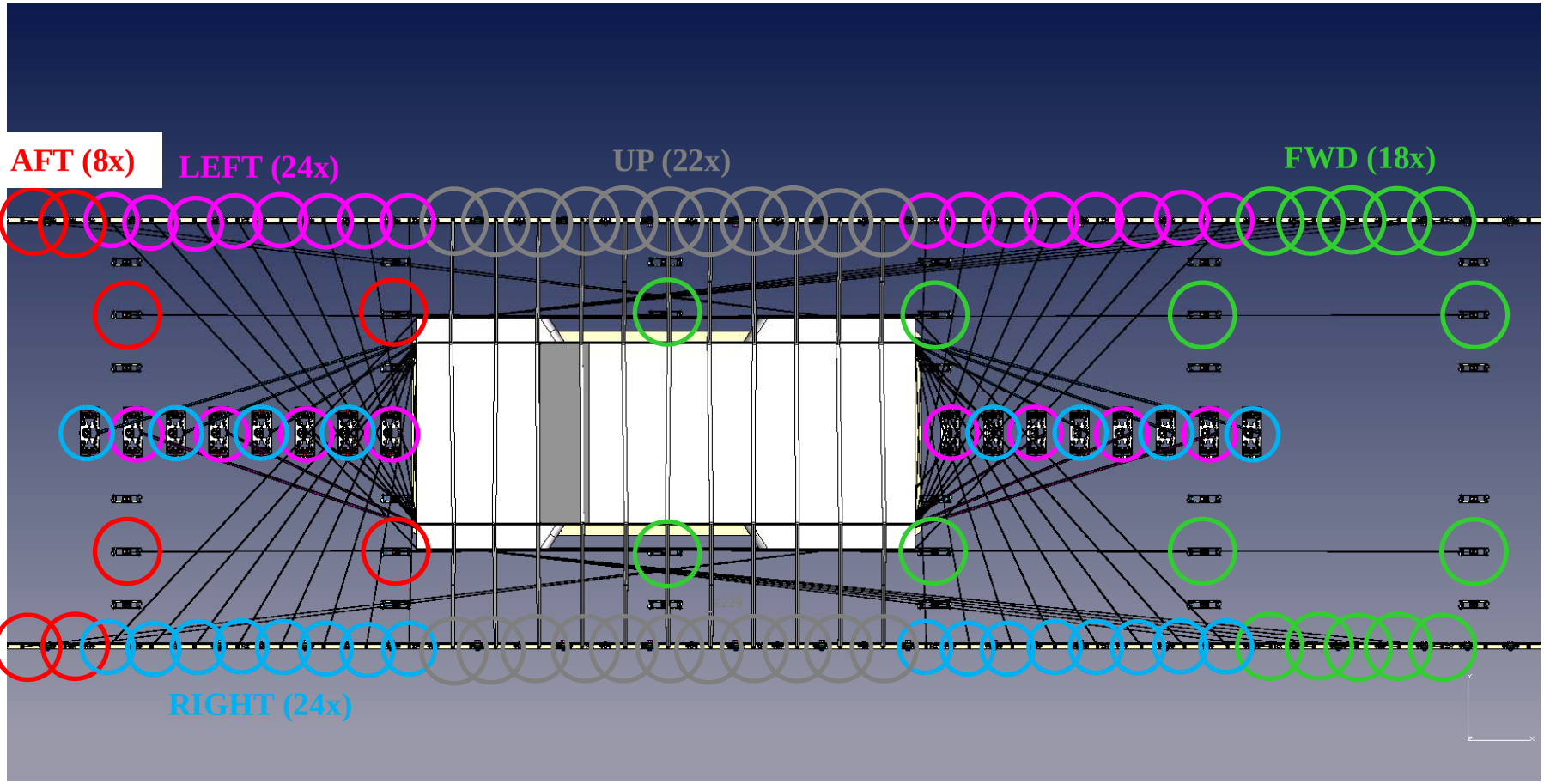
The most critical load factors are given in the following table.

TIEDOWN LOCATION	BODY STATION FROM	BODY STATION TO	ULTIMATE LOAD FACTOR FORWAR	AFT	SIDE	UP
Center Guide, and Side Guide Main Deck End Lock, End Stop	228	500	1.5	0.75	1.45	1.5
	500	1000			0.78	1.5
	1000	1480				1.5
	1480	2365			1.76	2.34

Reference:
25-55-66 Rev.L p.106

[redacted]

Tiedown Points for one Cougar
(B.A. 1161.2 – 1399.7, XY-Plane)



Tiedown Points for one Cougar

(FWD Direction)

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COUGAR, TIEDOWN CALCULATION FWD		AVAILABLE CAPABILITY					REQUIRED CAPABILITY			
DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE	CENTERLINE ANGLE	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE (KG)	TOTAL TIEDOWN ALLOWABLE (KG)	LOAD FACTOR	WEIGHT (KG)	TOTAL (KG)	MARGIN OF SAFETY
FWD	PALLET LOCK TIE DOWN RING	23	0	2	1964	30006	1,5	18646	27969	0,07
FWD	PALLET LOCK TIE DOWN RING	10	0	2	2268					
FWD	PALLET LOCK TIE DOWN RING	7	0	2	2268					
FWD	PALLET LOCK TIE DOWN RING	5	0	2	2268					
FWD	SIDE GUIDE, DOUBLE STUD FITTING	6	7	2	1247					
FWD	SIDE GUIDE, DOUBLE STUD FITTING	6	7	2	1247					
FWD	SIDE GUIDE, DOUBLE STUD FITTING	6	6	2	1247					
FWD	SIDE GUIDE, DOUBLE STUD FITTING	5	6	2	1247					
FWD	SIDE GUIDE, DOUBLE STUD FITTING	5	6	2	1247					

13.2.5. Pallet Lock – Tie Down Ring (STA 500-2365)

The following table summarizes tiedown fitting allowable loads for the pallet locks with ring tie

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DE							
		0°		30°				90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	5000	2268	N/A	N/A	N/A	N/A	N/A	N/A
	30°	4330	1964	N/A	N/A	N/A	N/A	N/A	N/A
	60°	2500	1134	N/A	N/A	N/A	N/A	N/A	N/A
	90° (Vertical)	0	0	N/A	N/A	N/A	N/A	N/A	N/A
Side	0° (Horizontal)	0	0	250	113	433	196	500	227
	30°	0	0	217	98	375	170	433	196
	60°	0	0	125	57	217	98	250	113
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	2500	1134	N/A	N/A	N/A	N/A	N/A	N/A
	60°	4330	1964	N/A	N/A	N/A	N/A	N/A	N/A
	90° (Vertical)	5000	2268	N/A	N/A	N/A	N/A	N/A	N/A
Aft	0° (Horizontal)	5000	2268	N/A	N/A	N/A	N/A	N/A	N/A
	30°	4330	1964	N/A	N/A	N/A	N/A	N/A	N/A
	60°	2500	1134	N/A	N/A	N/A	N/A	N/A	N/A
	90° (Vertical)	0	0	0	0	0	0	0	0

Values marked with N/A are not applicable, because this would cause other values to exceed the allowables.
Max. allowed center line angle +/- 3.2° for FWD/AFT and UP load.

See also chapter 13.5 for tiedown restrictions.

13.2.6. Side Guide - Double Stud Fitting

The following table summarizes tiedown fitting allowable loads for side guide - double stud fittings.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)							
		0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	2750	1247	2382	1080	1375	624	0	0
	30°	2382	1080	2063	936	1191	540	0	0
	60°	1375	624	1191	540	688	312	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0
Side	0° (Horizontal)	0	0	1000	454	1732	786	2000	907
	30°	0	0	866	393	1500	680	1732	786
	60°	0	0	500	227	866	393	1000	454
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	1675	760	1675	760	1675	760	1675	760
	60°	2901	1316	2901	1316	2901	1316	2901	1316
	90° (Vertical)	3350	1520	3350	1520	3350	1520	3350	1520
Aft	0° (Horizontal)	2750	1247	2382	1080	1375	624	0	0
	30°	2382	1080	2063	936	1191	540	0	0
	60°	1375	624	1191	540	688	312	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0

Reference: 25-55-66 Rev.L p.108 & p.111

Tiedown Points for one Cougar

(AFT Direction)

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COUGAR, TIEDOWN CALCULATION AFT		AVAILABLE CAPABILITY					REQUIRED CAPABILITY			
DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE	CENTERLINE ANGLE	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE (KG)	TOTAL TIEDOWN ALLOWABLE (KG)	LOAD FACTOR	WEIGHT (KG)	TOTAL (KG)	MARGIN OF SAFETY
AFT	PALLET LOCK TIE DOWN RING	12	0	2	2268	14060	0,75	18646	13985	0,00
AFT	PALLET LOCK TIE DOWN RING	8	0	2	2268					
AFT	SIDE GUIDE, DOUBLE STUD FITTING	7	10	2	1247					
AFT	SIDE GUIDE, DOUBLE STUD FITTING	7	6	2	1247					

13.2.5. Pallet Lock – Tie Down Ring (STA 500-2365)

The following table summarizes tiedown fitting allowable loads for the pallet locks with ring tiedowns.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)							
		0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	5000	2268	N/A	N/A	N/A	N/A	N/A	N/A
	30°	4330	1964	N/A	N/A	N/A	N/A	N/A	N/A
	60°	2500	1134	N/A	N/A	N/A	N/A	N/A	N/A
	90° (Vertical)	0	0	N/A	N/A	N/A	N/A	N/A	N/A
Side	0° (Horizontal)	0	0	250	113	433	196	500	227
	30°	0	0	217	98	375	170	433	196
	60°	0	0	125	57	217	98	250	113
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	2500	1134	N/A	N/A	N/A	N/A	N/A	N/A
	60°	4330	1964	N/A	N/A	N/A	N/A	N/A	N/A
	90° (Vertical)	5000	2268	N/A	N/A	N/A	N/A	N/A	N/A
Aft	0° (Horizontal)	5000	2268	N/A	N/A	N/A	N/A	N/A	N/A
	30°	4330	1964	N/A	N/A	N/A	N/A	N/A	N/A
	60°	2500	1134	N/A	N/A	N/A	N/A	N/A	N/A
	90° (Vertical)	0	0	0	0	0	0	0	0

Values marked with N/A are not applicable, because this would cause other values to exceed the allowables.
Max. allowed center line angle +/- 3.2° for FWD/AFT and UP load.

See also chapter 13.5 for tiedown restrictions.

13.2.8. Side Guide - Double Stud Fitting

The following table summarizes tiedown fitting allowable loads for side guide - double stud fittings.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES)							
		0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	2750	1247	2382	1080	1375	624	0	0
	30°	2382	1080	2063	936	1191	540	0	0
	60°	1375	624	1191	540	688	312	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0
Side	0° (Horizontal)	0	0	1000	454	1732	786	2000	907
	30°	0	0	866	393	1500	680	1732	786
	60°	0	0	500	227	866	393	1000	454
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	1675	760	1675	760	1675	760	1675	760
	60°	2901	1316	2901	1316	2901	1316	2901	1316
	90° (Vertical)	3350	1520	3350	1520	3350	1520	3350	1520
Aft	0° (Horizontal)	2750	1247	2382	1080	1375	624	0	0
	30°	2382	1080	2063	936	1191	540	0	0
	60°	1375	624	1191	540	688	312	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0

Reference: 25-55-66
Rev.L p.108 & p.111

Tiedown Points for one Cougar

(LEFT/RIGHT Direction)

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COUGAR, TIEDOWN CALCULATION RIGHT		AVAILABLE CAPABILITY					REQUIRED CAPABILITY			
DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE	CENTERLINE ANGLE	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE (KG)	TOTAL TIEDOWN ALLOWABLE (KG)	LOAD FACTOR	WEIGHT (KG)	TOTAL (KG)	MARGIN OF SAFETY
RIGHT	SIDE GUIDE, DOUBLE STUD FITTING	31	88	2	786	14692	0,78	18646	14544	0,01
RIGHT	SIDE GUIDE, DOUBLE STUD FITTING	30	80	2	786					
RIGHT	SIDE GUIDE, DOUBLE STUD FITTING	28	73	2	680					
RIGHT	SIDE GUIDE, DOUBLE STUD FITTING	26	65	2	680					
RIGHT	SIDE GUIDE, DOUBLE STUD FITTING	23	60	2	680					
RIGHT	SIDE GUIDE, DOUBLE STUD FITTING	21	53	2	680					
RIGHT	SIDE GUIDE, DOUBLE STUD FITTING	16	46	2	680					
RIGHT	SIDE GUIDE, DOUBLE STUD FITTING	16	49	2	680					
RIGHT	CENTER GUIDE, DOUBLE STUD FITTING	18	41	2	393					
RIGHT	CENTER GUIDE, DOUBLE STUD FITTING	17	27	2	393					
RIGHT	CENTER GUIDE, DOUBLE STUD FITTING	15	20	2	454					
RIGHT	CENTER GUIDE, DOUBLE STUD FITTING	13	16	2	454					

13.2.8. Side Guide - Double Stud Fitting

The following table summarizes tiedown fitting allowable loads for side guide - double stud fittings.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES) 0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	2750	1247	2382	1080	1375	624	0	0
	30°	2382	1080	2063	936	1191	540	0	0
	60°	1375	624	1191	540	688	312	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0
Side	0° (Horizontal)	0	0	1000	454	1732	[illegible]	2000	[illegible]
	30°	0	0	866	393	1500	680	1732	786
	60°	0	0	500	227	866	393	1000	454
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	1675	760	1675	760	1675	760	1675	760
	60°	2901	1316	2901	1316	2901	1316	2901	1316
	90° (Vertical)	3350	1520	3350	1520	3350	1520	3350	1520
Aft	0° (Horizontal)	2750	1247	2382	1080	1375	624	0	0
	30°	2382	1080	2063	936	1191	540	0	0
	60°	1375	624	1191	540	688	312	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0

13.2.11. Center Guides - Double Stud Fitting

The following table summarizes tiedown fitting allowable loads for Center Guides - double stud fittings.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES) 0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	3000	1361	2598	1178	1500	680	0	0
	30°	[illegible]	1178	2250	1021	1299	589	0	0
	60°	1500	[illegible]	1299	589	750	340	0	0
	90° (Vertical)	0	0	[illegible]	0	0	0	0	0
Side	0° (Horizontal)	0	0	1000	454	1732	786	2000	907
	30°	0	0	866	393	1500	680	1732	786
	60°	0	0	500	227	866	393	1000	454
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	1500	680	1500	680	1500	680	1500	680
	60°	2598	1178	2598	1178	2598	1178	2598	1178
	90° (Vertical)	3000	1361	3000	1361	3000	1361	3000	1361
Aft	0° (Horizontal)	3000	1361	2598	1178	1500	680	0	0
	30°	2598	1178	2250	1021	1299	589	0	0
	60°	1500	680	1299	589	750	340	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0

Reference: 25-55-66 Rev.L p.111 & p.114

Tiedown direction RIGHT shown.

Direction LEFT is similar.

Tiedown Points for one Cougar

(UP Direction)

COUGAR, TIEDOWN CALCULATION UP		AVAILABLE CAPABILITY					REQUIRED CAPABILITY			
DIRECTION	TIEDOWN LOCATION	FLOOR ANGLE	CENTERLINE ANGLE	NUMBER OF TIEDOWN FITTINGS	TIEDOWN ALLOWABLE (KG)	TOTAL TIEDOWN ALLOWABLE (KG)	LOAD FACTOR	WEIGHT (KG)	TOTAL (KG)	MARGIN OF SAFETY
UP	SIDE GUIDE, DOUBLE STUD FITTING	57	90	2	1316	28952	1,5	18646	27969	0,03
UP	SIDE GUIDE, DOUBLE STUD FITTING	57	90	2	1316					
UP	SIDE GUIDE, DOUBLE STUD FITTING	57	90	2	1316					
UP	SIDE GUIDE, DOUBLE STUD FITTING	62	90	2	1316					
UP	SIDE GUIDE, DOUBLE STUD FITTING	63	90	2	1316					
UP	SIDE GUIDE, DOUBLE STUD FITTING	63	90	2	1316					
UP	SIDE GUIDE, DOUBLE STUD FITTING	63	90	2	1316					
UP	SIDE GUIDE, DOUBLE STUD FITTING	63	90	2	1316					
UP	SIDE GUIDE, DOUBLE STUD FITTING	63	90	2	1316					
UP	SIDE GUIDE, DOUBLE STUD FITTING	63	90	2	1316					
UP	SIDE GUIDE, DOUBLE STUD FITTING	63	90	2	1316					

13.2.8. Side Guide - Double Stud Fitting

The following table summarizes tiedown fitting allowable loads for side guide - double stud fittings.

RESTRAINT DIRECTION	FLOOR ANGLE (DEGREES)	CENTERLINE ANGLE (DEGREES) 0°		30°		60°		90°	
		ALLOWABLE LOAD							
		LB	KG	LB	KG	LB	KG	LB	KG
Forward	0° (Horizontal)	2750	1247	2382	1080	1375	624	0	0
	30°	2382	1080	2063	936	1191	540	0	0
	60°	1375	624	1191	540	688	312	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0
Side	0° (Horizontal)	0	0	1000	454	1732	786	2000	907
	30°	0	0	866	393	1500	680	1732	786
	60°	0	0	500	227	866	393	1000	454
	90° (Vertical)	0	0	0	0	0	0	0	0
Up	0° (Horizontal)	0	0	0	0	0	0	0	0
	30°	1675	760	1675	760	1675	760	1675	[illegible]
	60°	2901	1316	2901	1316	2901	1316	290	1316
	90° (Vertical)	3350	1520	3350	1520	3350	1520	3350	[illegible]
Aft	0° (Horizontal)	2750	1247	2382	1080	1375	624	0	0
	30°	2382	1080	2063	936	1191	540	0	0
	60°	1375	624	1191	540	688	312	0	0
	90° (Vertical)	0	0	0	0	0	0	0	0

Reference: 25-55-66 Rev.L p.111

[redacted]

Summary - Tall Rigid Cargo Requirement ignored

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- Only Telair hardware was considered (no Boeing seat track).
- One (1) Cougar can be restrained on the main deck when the tall rigid cargo restriction is ignored as per the NTSB's request for analytical purposes only (not permitted under Telair manual).
- In this example, the Cougar was located in an area with the smallest load factors (fwd of B.A. 1480).
- It is not possible to safely and properly secure this vehicle aft of B.A. 1480.
- The occupied space is 679 inches.