BALANCE AND MANOEUVRING LOADS

57-004

Prepared by

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Table of contents

1. General……………………………………………………………………3
2. Aircraft lift equations…………………………………………………... .4
3. Conclusions……………………………………………………………. ..5
4. Geometry and aerodynamic DATA……………………………………....6
5. Fuselage zero lift pitching moment…………………………………….....8
6. Fuselage pitching moment curve slope……………………………..........8
7. Design speeds & Flight envelope…………………………………… ..10
8. CS-VLA 421 Balancing loads……………………………………… ..11
9. CS-VLA 423 Maneuvering loads……………………………….…. 12
10. CS-VLA 455 Gust Loads………………………………………………. .15
11. CS-VLA 441-443 Maneuvering loads on Vertical tail……………..… 15
12. CS-VLA 349; 455 Aileron Loads………………………………….. 17

References

1. F 2245-04-06 Standard Specifications for Design and Performance of a Light Sport Airplane
2. Roskam, Jan Airplane Design Part VI Preliminary Calculations of Aerodynamic, Thrust and Power Characteristics - 2004
3. 57-003 Flight Envelope
4. http://www.aoe.vt.edu/~lutze/AOE3134/- Maneuvering Flight

General symbols

Symbol	Definition	Dimension
a	speed of sound	m/s
x.ac , a_c	aerodynamic center (% MAC)	
Xac	aerodynamic center location	m
A	wing aspect ratio	
b	wing span	m
cLα	section lift curve slope	1/°
CLα	lift curve slope	1/°
CLmax	maximum lift coefficient	
cmo	zero lift pitching moment	
ew	span efficiency factor	
iw	wing incidence	°
MAC	mean aerodynamic chord	m

L	load	
Ptot	total load	
Mtot	total moment	
S	surface area	m^2
Swet	wetted area	m^2
V	speed	m/s^2
Ude	derived gust velocity	m/s
xcg	center of gravity location (% MAC)	
α	incidence	°
αCLmax	stall incidence	°
ε	thickness	
λ	taper ratio	
χ	sweep angle	°
ρ	air density	kg/m^3
η.h	dynamic pressure	
δ	elevator deflection	
dε_d α	downwash gradient	

SUBSCRIPTS

W	wing
H , HT	horizontal tail
VT	vertical tail
B	fuselage
WB	wing -fuselage
AC	aircraft

1. General

This report is dealing with the Balance & Maneuvering loads for aircraft LoCamp 600Kg, according to . F 2245-04-06 Standard Specifications for Design and Performance of a Light Sport Airplane.

The loading was investigated for all airspeeds, load factors and heights inside of Flight Envelope and for the conditions of following paragraphs: 5.4.1, 5.4.2, 5.4.3, 5.5 and 5.7.1.

The landing, take-off and the loading on flaps are not covered in this report.

For this report the area of wing tips is included in total wing area.

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2. Aircraft Lift Equations

$C_{L\delta h} := \tau \cdot C_{L\alpha h}$ Elevator lift curve slope

$$A_{11} := C_{L\alpha w} \cdot \left(xcg - xca_{vp}\right) - C_{L\alpha h} \cdot \left(1 - d\varepsilon\_d\alpha\right) \cdot (xao - xcg) \cdot \eta_h \cdot \frac{SH}{SW}$$

$$A_{12} := -C_{L\delta h} \cdot (xao - xcg) \cdot \eta_h \cdot \frac{SH}{SW}$$

$$A_{21} := C_{L\alpha w} + C_{L\alpha h} \cdot \left(1 - d\varepsilon\_d\alpha\right) \cdot \eta_h \cdot \frac{SH}{SW}$$

$$A_{22} := C_{L\delta h} \cdot \eta_h \cdot \frac{SH}{SW}$$

The complete aircraft lift equation:

$$A_{21} \cdot \alpha + A_{22} \cdot \delta_e + C_{L\alpha h} \cdot \left[-\varepsilon_0 - ics + \frac{63 \cdot g \cdot (n - 1) \cdot (dH - xcg \cdot MAC)}{V^2} \right] \cdot \eta_h \cdot \frac{SH}{SW}$$

The aircraft pitch moment equation:

$$A_{11} \cdot \alpha + A_{12} \cdot \delta_e - C_{L\alpha h} \cdot \left[-\varepsilon_0 - ics + \frac{63 \cdot g \cdot (n - 1) \cdot (dH - xcg \cdot MAC)}{V^2} \right] \cdot (xao - xcg) \cdot \eta_h \cdot \frac{SH}{SW} + C_{m0w} + C_{m0f}$$

Wing pitching moment at zero lift $C_{m0w} := -0.068$

Fuselage pitching moment at zero lift $C_{m0f} := -0.0003$

$C_m := 0$ $C_L = C_{LAC}$

ics stabilizer zero incidence =5°

$$0 = A_{11}\cdot\alpha + A_{12}\cdot\delta_e - C_{L\alpha h}\cdot\left[-\varepsilon_0 - ics + \frac{63\cdot g\cdot(n-1)\cdot(dH - xcg\cdot MAC)}{V^2}\right]\cdot(xao - xcg)\cdot\eta_h\cdot\frac{SH}{SW} + C_{m0w} + C_{m0f}$$

$$C_L = A_{21}\cdot\alpha + A_{22}\cdot\delta_e + C_{L\alpha h}\cdot\left[-\varepsilon_0 - ics + \frac{63\cdot g\cdot(n-1)\cdot(dH - xcg\cdot MAC)}{V^2}\right]\cdot\eta_h\cdot\frac{SH}{SW}$$

$$\begin{pmatrix}\alpha\\ \delta_e\end{pmatrix} := \mathrm{Find}(\alpha, \delta_e)$$

:

Wing load: $P_{w=} := q\cdot SW\cdot C_{L\alpha w}\cdot\alpha$

Tail load:

$$P_{Tail} := C_{L\alpha h}\cdot\left[\alpha - (\varepsilon_0 + d\varepsilon\_d\alpha\cdot\alpha) - ics + \frac{63\cdot g\cdot(n-1)\cdot(dH - xcg\cdot MAC)}{V^2} + \tau\cdot\delta_e\right]\cdot\eta_h\cdot SH\cdot q$$

3. Conclusions

The aircraft LOCamp behaves well in all of the loading cases investigated.

4. Geometry and aerodynamic DATA

WING		
Airfoil	4416	
t/c	0.16	
Atip	0.70	
b [m]	9.1	: Span
S [m2]	14.91	: Surface
AR	4.8	: Aspect ratio
TR	1	: Taper ratio
MAC [m]	1.594	: MAC
XLEMAC [m]	1.02	: X coordinate of Wing Leading edge - The origin of Coordinate System
$cL_{,\alpha,2D}$ [1/deg]	0.1050	: Section lift curve slope DATCOM tab. 4.1.1-A
$cL_{,\alpha,2D}$ [1/rad]	6.0161	: Section lift curve slope DATCOM tab. 4.1.1-A
$cL_{,0,2D}$	0.3912	: Lift coefficient at zero angle of attack
cm,c/4,0,2D	-0.0895	: Section pitching moment coefficient acc. To MAC/4
$x_{CA,2D}$ [%MAC]	0.2440	: Aerodynamic center location of airfoil acc. To DATCOM fig. 4.1.2.2-3
iW [°]	2.0000	
α_0 [°]	-4.3321	: DATCOM 4.1.3.1-a
CL,α,W [1/rad]	4.4670	: Aircraft Lift Curve Slope
Cm,c/4,0,W	-0.0680	: DATCOM 4.1.4.1-a
$Cm_{,\alpha,W}$ [1/deg]	-0.0005	: Wing pitching moment curve slope
$Cm_{,\alpha,W}$ [1/rad]	-0.0268	: Wing pitching moment curve slope
Cm,CA,W	-0.0680	: Wing pitching moment
$X_{CA,W}$ [%MAC]	0.2440	: Wing aerodynamic center location. DATCOM § 4.1.4.2
$Cm_{,0,F}$	-0.0003	: Fuselage pitching moment DATCOM § 4.3.2.1
$Cm_{,\alpha,F}$ [1/deg]	0.0028	: Fuselage pitching moment curve slope

		DATCOM § 4.2.2
$X_{CA,b}$ [%MAC]	0.2410	: Wing body aerodynamic center
K_A	0.1431	: DATCOM 4.4.1-69a
K_λ	1.0000	: DATCOM 4.4.1-69b
K_H	0.9646	: DATCOM 4.4.1-70
$\varepsilon 0$ [°]	0	
$(\delta\varepsilon/\delta\alpha)$	0.4207	: DATCOM 4.4.1-h
HORIZONTAL TAIL		
Section	NACA 0006	
b [m]	2.58	
S [m2]	2.842	
Se [m2]	1.431	
AR	2.3422	
TR	0.5440	
MAC [m]	1.1340	
ics [deg]	5.0000	: Stabilizer zero incidence
CL,a,H [1/deg]	0.0510	Horizontal tail lift curve slope
Se/SH	0.5035	
τ	0.7210	
d [m]	4.0220	: Distance between Wing LE and HT Aerodynamic center
x_H [m]	2.4280	: Distance between Wing TE and HT Aerodynamic center ROSKAM fig. 8.63
h_H [m]	0.707	: ROSKAM fig. 8.66
l_H [m]	3.6331	: Distance between Wing A_C and HT A_C ROSKAM fig. 8.66
γ [°]	18.2	: ROSKAM fig. 8.63
lt [m]	3.6139	: Distance from A/C c.g to A_C of HT see CS-VLA 423(d)(3)
VERTICAL TAIL		
Section	NACA 0006	
b [m]	1.29	
S [m2]	1.421	
AR	1.1711	

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5. Fuselage zero lift pitching moment

(Cm,0) Fuselage - DATCOM: § 4.3.2.1					
Strip	w [m]	α_{0W} [°]	$(i_{CL})_B$ [°]	Δx [m]	$w_F^2.(\alpha_{0,W} + (i_{CL})_B).\Delta x$
1	0.6600	-2.3321	8	0.2460	0.6074
2	0.6600		8	0.5000	1.2345
3	0.6600		8	0.5000	1.2345
4	0.6600		8	0.5000	1.2345
5	0.6600		0	0.5000	-0.5079
6	0.6600		0	0.5940	-0.6034
7	0.6600		0	0.5000	-0.5079
8	0.6325		-5	0.4600	-1.3493
9	0.5060		-5	0.4600	-0.8635
10	0.3795		-5	0.4600	-0.4857
11	0.2530		-5	0.4600	-0.2159
12	0.1265		-5	0.4600	-0.0540
13	0.0000		-5	0.4600	0.0000
				$\Sigma =$	-0.2769

Fuselage length [m]	6.1			
Fuselage max width [m]	0.66			
Fuselage max height [m]	0.71			
Equivalent diameter [m]	0.7724			
Body fineness ratio	7.8972	**Fuselage zero lift pitching moment**		
Apparent mass factor (k2-k1)	0.9100	Datcom Fig. 4.22.1.1-20a	$(Cm,0)_F$	-0.0003

6. Fuselage pitching moment curve slope

Cm,α,WB - UPWASH - DATCOM: § 4.2.2.1

Strip	x1 [m]	x1/Cr	Δx [m]	w [m]	(δε/δα)m	(δε/δα)1	$w^2.((\delta\varepsilon/\delta\alpha)_1+1).\Delta x$
1	0.2500	0.1568	0.5000	0.6600	-	3.0000	0.8667
2	0.7500	0.4705	0.5000	0.6600	1.4200	-	0.5250
3	1.2500	0.7842	0.5000	0.6600	0.8500	-	0.4017
4	1.6230	1.0182	0.2460	0.6600	0.7500	-	0.1870

Cm,α,WB - DOWNWASH - DATCOM: § 4.2.2.1

Strip	x2 [m]	x2/lH_1	Δx [m]	w [m]	(δε/δα)m	(δε/δα)2	$w^2.((\delta\varepsilon/\delta\alpha)2+1).\Delta x$
1	0.2500	0.0688	0.5000	0.6325	0.4207	0.0399	0.2080
2	0.7500	0.2064	0.5000	0.5060		0.1196	0.1433
3	1.2500	0.3441	0.5000	0.3795		0.1993	0.0864
4	1.7500	0.4817	0.5000	0.2530		0.2791	0.0409
5	2.2500	0.6193	0.5000	0.1265		0.3588	0.0109
6	2.5940	0.7140	0.1880	0.0000		0.4137	0.0000
						0.0000	0.0000
						0.0000	0.0000
						0.0000	0.0000
						0.0000	0.0000
						Σ =	0.4895

Fuselage pitching moment curve slope

$(C_{m,\alpha})_F$ [1/deg] 0.0031

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7. DESIGN SPEEDS & FLIGHT ENVELOPE

WEIGHT & BALANCE LIMITS [%MAC]				
	W [kg]	FWD	AFT	
MTOW	600	25.3%	32.0%	
Mmin	450	23.9%	29.3%	

DESIGN AIRSPEED & FLIGHT ENVELOPE @ SEA LEVEL				
	MTOW=600 kg		Mmin=450 kg	
	KIAS	m/s	KIAS	m/s
V_{S+}	41	21.1	35.5	18.3
$V_{S0,n=2}$	35	18.0	30	15.5
V_{S-}	50	25.9	43.5	22.4
V_A	82	42.2	75	38.6
V_C	94.8	48.8	94.8	48.8
V_H	105	55.6	105	55.6
V_{NE}	115	54	115	54
V_D	132.7	68.3	132.7	68.3

CG Range is calculated in Report 57-005 CG Range

8. 5.4.1 : BALANCING LOADS

Weight [kg]	X_{CG} % MAC	V KIAS	n	L_W [kg]	L_H [kg]	NOTE	C_L	α [°]	δe [°]	$X_{CG,aft}$	Margin of stability
600	0.25	41	1,00	608,91	-8,91	Landing	1,49	19,38	-12,95	0,410	-0,013
		85	4,00	2.439,22	-39,22	Pull up at V_A	1,39	18,06	-16,77	0,409	-0,013
		94,8	3,78	2.320,56	-52,56	Positive gust at V_C	1,05	13,81	-12,49	0,392	-0,012
		132,7	4,00	2.513,74	-113,74	Pull up at V_D	0,57	7,64	-5,61	0,403	-0,013
		132,7	-0,82	-363,06	-128,94	Negative gust at V_D	-0,12	-1,10	4,39	0,394	-0,012
		94,8	-1,78	-997,90	-70,10	Negative gust at V_C	-0,50	-5,94	10,90	0,401	-0,012
		85	-2,00	-1.141,85	-58,15	Dive at V_A	-0,69	-8,45	13,93	0,394	-0,012
		50	-1,00	-578,91	-21,09	Negative stall	-1,00	-12,39	22,12	0,409	-0,013
		85	1,00	648,69	-48,69	Loads acc. To JAR-VLA 423(d) at V_A	0,35	4,80	-1,33	0,403	-0,013
		132,7	1,00	723,20	-123,20	Loads acc. To JAR-VLA 423(d) at V_D	0,14	2,20	0,93	0,408	-0,013
		94,8	1,00	661,33	-61,33	Loads acc. To JAR-VLA 425(a)(1) at V_C	0,28	3,94	-0,46	0,409	-0,013
	0.32	41	1,00	591,29	8,71	Landing	1,49	18,82	-6,13	0,398	-0,007
		85	4,00	2.368,77	31,23	Pull up at V_A	1,39	17,54	-10,16	0,391	-0,006
		94,8	3,78	2.253,98	14,02	Positive gust at V_C	1,05	13,42	-7,27	0,403	-0,007
		128	4,00	2.434,49	-34,49	Pull up at V_D	0,61	7,95	-3,29	0,406	-0,007
		128	-0,82	-357,41	-134,59	Negative gust at V_D	-0,13	-1,17	4,24	0,404	-0,007
		94,8	-1,78	-966,54	-101,46	Negative gust at V_C	-0,50	-5,75	8,68	0,405	-0,007
		85	-2,00	-1.106,62	-93,38	Dive at V_A	-0,69	-8,19	10,86	0,402	-0,007
		50	-1,00	-561,29	-38,71	Negative stall	-1,00	-12,01	16,21	0,391	-0,006
		85	1,00	631,07	-31,07	Loads acc. To JAR-VLA 423(d) at V_A	0,35	4,67	0,11	0,394	-0,006
		132,7	1,00	705,59	-105,59	Loads acc. To JAR-VLA 423(d) at V_D	0,14	2,14	1,25	0,396	-0,006
450	0.24	36	1,00	459,69	-9,69	Landing	1,45	18,97	-14,45	0,391	-0,013
		71	4,00	1.837,75	-37,75	Pull up at V_A	1,49	19,50	-21,86	0,393	-0,013
		94,8	4,32	2.010,19	-66,19	Positive gust at V_C	0,90	11,97	-12,54	0,394	-0,013
		132,7	4,00	1.927,93	-127,93	Pull up at V_D	0,43	5,86	-4,36	0,410	-0,014
		132,7	-1,18	-405,11	-125,89	Negative gust at V_D	-0,13	-1,23	5,05	0,401	-0,014
		94,8	-2,32	-980,43	-63,57	Negative gust at V_C	-0,48	-5,84	12,17	0,407	-0,014
		71	-2,00	-864,62	-35,38	Dive at V_A	-0,74	-9,18	17,66	0,403	-0,014
		44	-1,00	-436,50	-13,50	Negative stall	-0,97	-12,06	25,10	0,395	-0,013
	0.29	36	1,00	449,05	0,95	Landing	1,45	18,54	-8,66	0,391	-0,008
		71	4,00	1.795,16	4,84	Pull up at V_A	1,49	19,05	-15,84	0,398	-0,009
		94,8	4,32	1.964,19	-20,19	Positive gust at V_C	0,90	11,69	-8,93	0,392	-0,008
		132,7	4,00	1.885,34	-85,34	Pull up at V_D	0,43	5,73	-2,81	0,410	-0,010
		132,7	-1,18	-392,55	-138,45	Negative gust at V_D	-0,13	-1,19	4,57	0,401	-0,009
		94,8	-2,32	-955,73	-88,27	Negative gust at V_C	-0,48	-5,69	10,23	0,405	-0,009
		71	-2,00	-843,32	-56,68	Dive at V_A	-0,74	-8,95	14,87	0,406	-0,010
		44	-1,00	-425,86	-24,14	Negative stall	-0,97	-11,77	20,85	0,392	-0,008

Margin of stability limits	Max. Load on WING	Max. Load on HT
-0,00589	2.513,7	31,23
-0,01441	-1.141,8	-138,45

9. CS-VLA 423(a): MANOEUVRING LOADS (sudden maneuver)

A sudden maximum deflection of the elevator at V_A first to the +25° and followed to the - 25°. The average loading is find out from figure B11 and the distribution from fig. B7 of Appendix B will be used.
From Fig. B1 the limit average maneuvering control surface loading is find out from linear interpolation between curve A and B

W/S=40.2kg/sqm ----> kW=105kg/sqm----> w=95.5 kg/sqm

y [m]	c(y) [m]	x_{LE} [m]	Hinge 1	Hinge 2	P1 kg/m	P2 kg/m	P3 kg/m	ΣP [kg]	M1 [kg]	M2 [kg]	M3 [kg]	ΣM [kgm]
0.00	1.43	0.00	0.67	0.69	31.85	2.63	34.98	-	-7.08	0.04	9.06	-
0.05	1.40	0.02	0.67	0.69	30.98	2.63	34.65	3.47	-6.70	0.04	8.76	0.10
0.10	1.38	0.04	0.67	0.69	30.11	2.63	34.32	3.41	-6.33	0.04	8.47	0.11
0.15	1.35	0.05	0.67	0.69	29.24	2.63	34.00	3.35	-5.97	0.04	8.19	0.11
0.20	1.33	0.07	0.67	0.69	28.37	2.63	33.67	3.29	-5.62	0.04	7.90	0.11
0.25	1.30	0.09	0.67	0.69	27.50	2.63	33.34	3.23	-5.28	0.04	7.62	0.12
0.30	1.28	0.11	0.67	0.69	26.64	2.63	33.02	3.17	-4.95	0.04	7.35	0.12
0.35	1.25	0.13	0.67	0.69	25.77	2.63	32.69	3.11	-4.63	0.04	7.08	0.12
0.40	1.23	0.15	0.67	0.69	24.90	2.63	32.36	3.05	-4.33	0.04	6.81	0.12
0.45	1.20	0.16	0.67	0.69	24.03	2.63	32.04	2.99	-4.03	0.04	6.55	0.13
0.50	1.18	0.18	0.67	0.69	23.16	2.63	31.71	2.93	-3.74	0.04	6.29	0.13
0.55	1.15	0.20	0.67	0.69	22.29	2.63	31.38	2.87	-3.47	0.04	6.03	0.13
0.60	1.13	0.22	0.67	0.69	21.42	2.63	31.06	2.82	-3.20	0.04	5.78	0.13
0.65	1.10	0.24	0.67	0.69	20.55	2.63	30.73	2.76	-2.95	0.04	5.54	0.13
0.70	1.08	0.25	0.67	0.69	19.68	2.63	30.40	2.70	-2.70	0.04	5.29	0.13
0.75	1.05	0.27	0.67	0.69	18.81	2.63	30.08	2.64	-2.47	0.04	5.05	0.13
0.80	1.03	0.29	0.67	0.69	17.95	2.63	29.75	2.58	-2.25	0.04	4.82	0.13
0.85	1.00	0.31	0.67	0.69	17.08	2.63	29.42	2.52	-2.04	0.04	4.59	0.13
0.90	0.98	0.33	0.67	0.69	16.21	2.63	29.10	2.46	-1.83	0.04	4.36	0.13
0.95	0.95	0.35	0.67	0.69	15.34	2.63	28.77	2.40	-1.64	0.04	4.14	0.13
1.00	0.93	0.36	0.67	0.69	14.47	2.63	28.44	2.34	-1.46	0.04	3.92	0.13
1.05	0.90	0.38	0.67	0.69	13.60	2.63	28.12	2.28	-1.29	0.04	3.70	0.12
1.10	0.88	0.40	0.67	0.69	12.73	2.63	27.79	2.22	-1.13	0.04	3.49	0.12
1.15	0.85	0.42	0.67	0.69	11.86	2.63	27.46	2.16	-0.98	0.04	3.28	0.12
1.20	0.83	0.44	0.67	0.69	10.99	2.63	27.14	2.10	-0.84	0.04	3.08	0.12
1.25	0.80	0.45	0.67	0.69	10.12	2.63	26.81	2.04	-0.72	0.04	2.88	0.11
1.30	0.78	0.47	0.67	0.69	9.26	2.63	26.49	1.98	-0.60	0.04	2.68	0.11

P_{TOT}=141.72kg **M_{TOT}=6.33kgm**

The load **@ Stabilizer spar** due to sudden maneuvering- acting downwards is **151.2 kg.**
The load **@ FWD fittings** of stabilizer -acting upwards is **9.5kg**

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CS-VLA 423(b): MANOEUVRING LOADS (checked maneuver)

The maneuvering tail load increment @ VD (up and down) is find out from fig. B2 , B7 and B8 of appendix B.

l/V=0.0523437m/kts 6.1 is length of A/C $T/W_{n=4}$=0.1415 T=84.9kg is added to the balancing load

Then the total load is T_{tot}=-117.65+-84.9=-202.55kg
The limit average maneuvering control surface loading is find out by linear interpolation of the value under the condition of CS VLA 423(a), and it is distributed acc. To fig. B7

y [m]	c(y) [m]	x_{LE} [m]	Hinge 1	Hinge 2	P1 [kg/m]	P2 [kg/m]	P3 [kg/m]	ΣP [kg]	M1 [kg]	M2 [kg]	M3 [kg]	ΣM [kg]
0.00	1.43	0.00	0.67	0.69	45.52	3.75	49.99	-	-10.12	0.05	12.95	-
0.05	1.40	0.02	0.67	0.69	44.28	3.75	49.52	4.96	-9.58	0.05	12.53	0.14
0.10	1.38	0.04	0.67	0.69	43.04	3.75	49.06	4.88	-9.05	0.05	12.11	0.15
0.15	1.35	0.05	0.67	0.69	41.79	3.75	48.59	4.79	-8.53	0.05	11.70	0.16
0.20	1.33	0.07	0.67	0.69	40.55	3.75	48.12	4.71	-8.03	0.05	11.30	0.16
0.25	1.30	0.09	0.67	0.69	39.31	3.75	47.66	4.62	-7.55	0.05	10.90	0.17
0.30	1.28	0.11	0.67	0.69	38.07	3.75	47.19	4.54	-7.08	0.05	10.50	0.17
0.35	1.25	0.13	0.67	0.69	36.83	3.75	46.72	4.45	-6.62	0.05	10.12	0.17
0.40	1.23	0.15	0.67	0.69	35.58	3.75	46.26	4.37	-6.18	0.05	9.74	0.18
0.45	1.20	0.16	0.67	0.69	34.34	3.75	45.79	4.28	-5.76	0.05	9.36	0.18
0.50	1.18	0.18	0.67	0.69	33.10	3.75	45.32	4.19	-5.35	0.05	8.99	0.18
0.55	1.15	0.20	0.67	0.69	31.86	3.75	44.86	4.11	-4.96	0.05	8.62	0.18
0.60	1.13	0.22	0.67	0.69	30.62	3.75	44.39	4.02	-4.58	0.05	8.27	0.19
0.65	1.10	0.24	0.67	0.69	29.37	3.75	43.92	3.94	-4.21	0.05	7.91	0.19
0.70	1.08	0.25	0.67	0.69	28.13	3.75	43.45	3.85	-3.87	0.05	7.56	0.19
0.75	1.05	0.27	0.67	0.69	26.89	3.75	42.99	3.77	-3.53	0.05	7.22	0.19
0.80	1.03	0.29	0.67	0.69	25.65	3.75	42.52	3.68	-3.21	0.05	6.89	0.19
0.85	1.00	0.31	0.67	0.69	24.41	3.75	42.05	3.60	-2.91	0.05	6.56	0.19
0.90	0.98	0.33	0.67	0.69	23.16	3.75	41.59	3.51	-2.62	0.05	6.23	0.18
0.95	0.95	0.35	0.67	0.69	21.92	3.75	41.12	3.43	-2.35	0.05	5.91	0.18
1.00	0.93	0.36	0.67	0.69	20.68	3.75	40.65	3.34	-2.09	0.05	5.60	0.18
1.05	0.90	0.38	0.67	0.69	19.44	3.75	40.19	3.25	-1.85	0.05	5.29	0.18
1.10	0.88	0.40	0.67	0.69	18.20	3.75	39.72	3.17	-1.62	0.05	4.99	0.17
1.15	0.85	0.42	0.67	0.69	16.95	3.75	39.25	3.08	-1.40	0.05	4.69	0.17
1.20	0.83	0.44	0.67	0.69	15.71	3.75	38.79	3.00	-1.21	0.05	4.40	0.17
1.25	0.80	0.45	0.67	0.69	14.47	3.75	38.32	2.91	-1.02	0.05	4.11	0.16
1.30	0.78	0.47	0.67	0.69	13.23	3.75	37.85	2.83	-0.85	0.05	3.83	0.16

P_{TOT}=202.55kg **M_{TOT}=9.05kgm**

The load **@ Stabilizer spar** due to sudden maneuvering- acting downwards is **216.2kg.**

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The load **@ FWD fittings** of stabilizer -acting upwards is **13.6kg.**

CS-VLA 423(d)(3): MANOEUVRING LOADS

Weight [kg]	X_{CG} [% MAC]	X_{CG} [m]	Height [m]	r_z [kg/m³]	V [KIAS]	n_i	n_f	Dn	x_{cg} [m]	DP [kg]	$L_{H,i}$ [kg]	$L_{H,f}$ [kg]	Maximum loads on HT
600	25,3%	1,423282	0	1,2250	85	1	4	3	0,014	-192,3	-48,7	-241,0	170,3
				1,2250	V_A	4	1	-3	0,014	192,3	-39,2	153,0	-315,5
				1,2250		1	-2	-3	0,014	192,3	-48,7	143,6	3,613936
				1,2250		-2	1	3	0,014	-192,3	-39,2	-231,5	
				1,2250	132,7	1	4	3	0,014	-192,3	-123,2	-315,5	
				1,2250	V_D	4	1	-3	0,014	192,3	-113,7	78,5	
				1,2250		1	-0,82	-1,82	0,014	116,6	-123,2	-6,6	
				1,2250		-0,82	1	1,82	0,014	-116,6	-113,7	-230,4	
	32,0%	1,53008	0	1,2250	85	1	4	3	0,121	-139,1	-31,1	-170,1	
				1,2250	V_A	4	1	-3	0,121	139,1	31,2	170,3	
				1,2250		1	-2	-3	0,121	139,1	-31,1	108,0	
				1,2250		-2	1	3	0,121	-139,1	31,2	-107,8	
				1,2250	132,7	1	4	3	0,121	-139,1	-105,6	-244,7	
				1,2250	V_D	4	1	-3	0,121	139,1	-34,5	104,6	
				1,2250		1	-0,82	-1,82	0,121	84,4	-105,6	-21,2	
				1,2250		-0,82	1	1,82	0,121	-84,4	-34,5	-118,9	
450	23,9%	1,400966	0	1,2250	71	1	4	3	0,014	-144,2	-48,7	-192,9	
				1,2250	V_A	4	1	-3	0,014	144,2	-123,2	21,0	
				1,2250		1	-2	-3	0,014	144,2	-61,3	82,9	
				1,2250		-2	1	3	0,014	-144,2	8,7	-135,5	
				1,2250	132,7	1	4	3	0,014	-144,2	31,2	-113,0	
				1,2250	V_D	4	1	-3	0,014	144,2	14,0	158,2	
				1,2250		1	-1,18	-2,18	0,014	104,8	-34,5	70,3	
				1,2250		-1,18	1	2,18	0,014	-104,8	-134,6	-239,4	
	29,3%	1,487042	0	1,2250	71	1	4	3	0,121	-104,3	-101,5	-205,8	
				1,2250	V_A	4	1	-3	0,121	104,3	-93,4	10,9	
				1,2250		1	-2	-3	0,121	104,3	-38,7	65,6	
				1,2250		-2	1	3	0,121	-104,3	-31,1	-135,4	
				1,2250	132,7	1	4	3	0,121	-104,3	-105,6	-209,9	
				1,2250	V_D	4	1	-3	0,121	104,3	-9,7	94,6	
				1,2250		1	-1,18	-2,18	0,121	75,8	-37,7	38,0	
				1,2250		-1,18	1	2,18	0,121	-75,8	-66,2	-142,0	

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10. GUST LOADS ACCORDING TO CS-VLA 425(a)(1)(2) e (d)

Weight [kg]	r [kg/m^3]	V	V [KIAS]	V [m/s]	m_g	K_g	U_{de} [m/s]	DL_{ht} [daN]	DL_{ht} [kg]	SL_{ht} [kg]	Maximum loads
600	1,225	V_F	41	21,1	9,4844	0,5645	7,62	28,92	29,49	-9,22	75,07
			41	21,1			-7,62	-28,92	-29,49	-68,20	-218,65
		V_C	94,8	48,8			15,24	133,76	136,40	75,07	
			94,8	48,8			-15,24	-133,76	-136,40	-197,73	
		V_D	132,7	68,3			7,62	93,60	95,45	-27,75	
			132,7	68,3			-7,62	-93,60	-95,45	-218,65	
450	1,225	V_F	36	18,5	7,1133	0,5043	7,62	0,00	0,00	0,00	
			36	18,5			-7,62	0,00	0,00	0,00	
		V_C	94,8	48,8			15,24	119,48	121,84	60,51	
			94,8	48,8			-15,24	-119,48	-121,84	-183,17	
		V_D	132,7	68,3			7,62	83,61	85,26	-37,94	
			132,7	68,3			-7,62	-83,61	-85,26	-208,46	

11. MANOEUVRING LOAD ACCORDING CS VLA 441(b), 443(b)

Limit average maneuvering control loading is get out from fig. B1 of Appendix B by linear interpolation between curve A and B, for 25° rudder deflection.

W/S= 40.2   kW=105 kg/sqm----> w=95.5kg/sqm

y m	c(y) m	x_{LE} m	Hinge 1	P1 kg/m	P2 kg/m	ΣP kg	M1 kg	M2 kg	ΣM kg m
0	1.427	0	0.667	85.174	51.104	-	-44.656	2.376	-
0.05	1.402	0.018	0.667	83.680	50.208	6.814	-44.083	1.706	-2.114
0.1	1.377	0.036	0.667	82.185	49.311	6.694	-43.501	1.058	-2.225
0.15	1.352	0.055	0.667	80.691	48.414	6.575	-42.912	0.433	-2.233
0.2	1.327	0.073	0.667	79.196	47.518	6.455	-42.316	-0.170	-2.236
0.25	1.302	0.091	0.667	77.702	46.621	6.336	-41.712	-0.750	-2.236
0.3	1.277	0.109	0.667	76.207	45.724	6.216	-41.100	-1.308	-2.235
0.35	1.252	0.127	0.667	74.713	44.828	6.097	-40.481	-1.844	-2.232
0.4	1.227	0.146	0.667	73.218	43.931	5.977	-39.855	-2.357	-2.228
0.45	1.202	0.164	0.667	71.724	43.034	5.857	-39.221	-2.848	-2.222
0.5	1.177	0.182	0.667	70.229	42.138	5.738	-38.580	-3.316	-2.215
0.55	1.152	0.200	0.667	68.735	41.241	5.618	-37.931	-3.762	-2.206
0.6	1.127	0.218	0.667	67.240	40.344	5.499	-37.274	-4.185	-2.195

y m	c(y) m	x_{LE} m	Hinge 1	P1 kg/m	P2 kg/m	ΣP kg	M1 kg	M2 kg	ΣM kg m
0.65	1.102	0.237	0.667	65.746	39.447	5.379	-36.611	-4.586	-2.183
0.7	1.076	0.255	0.667	64.251	38.551	5.260	-35.939	-4.964	-2.169
0.75	1.051	0.273	0.667	62.757	37.654	5.140	-35.260	-5.320	-2.154
0.8	1.026	0.291	0.667	61.262	36.757	5.021	-34.574	-5.654	-2.137
0.85	1.001	0.309	0.667	59.768	35.861	4.901	-33.880	-5.965	-2.118
0.9	0.976	0.328	0.667	58.273	34.964	4.781	-33.179	-6.253	-2.098
0.95	0.951	0.346	0.667	56.779	34.067	4.662	-32.470	-6.519	-2.077
1	0.926	0.364	0.667	55.284	33.171	4.542	-31.754	-6.763	-2.053
1.05	0.901	0.382	0.667	53.790	32.274	4.423	-31.030	-6.984	-2.029
1.1	0.876	0.400	0.667	52.295	31.377	4.303	-30.299	-7.183	-2.002
1.15	0.851	0.419	0.667	50.801	30.481	4.184	-29.560	-7.359	-1.974
1.2	0.826	0.437	0.667	49.306	29.584	4.064	-28.814	-7.513	-1.945
1.25	0.801	0.455	0.667	47.812	28.687	3.945	-28.061	-7.645	-1.914
1.3	0.776	0.473	0.667	46.318	27.791	3.825	-27.300	-7.754	-1.881

P_{TOT}=138.31kg **M_{TOT}=55.31kgm**

Load @ spar **55.4** kg acting sideward

Load @ FWD fittings **82.9** kg acting opposite sideward

GUST LOAD ON VERTICAL TAIL ACCORDING TO APPENDIX B FIG. B5

W/SV [kg/m2] =422.2

@80 KTS 90 [kg/m2]

@100 KTS 113 [kg/m2]

@97 KTS w = 98.05 [kg/m2]

Correction for average gust load due to aspect ratio 1.17

L_{VT},gust = 85.8 kg

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12. AILERON LOADS (CS-VLA § 455)

The average loading is find out from figures B11 and B1 of Appendix B and distribution from figure B9 using curve A (30° deflection) and curve B(20° deflection):

W/S= 41.4 kW=83 kg/sqm----> w=75.5kg/sqm

y m	c(y) m	Hinge 1	P1 kg/m	P2 kg/m	ΣP[kg]]	M1 kg	M3 kg	ΣM kgm
0	0,495	0,125	9,44	13,97	-	-0,59	1,72	-
0,05	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,1	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,15	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,2	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,25	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,3	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,35	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,4	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,45	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,5	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,55	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,6	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,65	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,7	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,75	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,8	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,85	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,9	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
0,95	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
1	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
1,05	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
1,1	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
1,15	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
1,2	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
1,25	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
1,3	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
1,35	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06
1,4	0,495	0,125	9,44	13,97	1,17	-0,59	1,72	0,06

P_{TOT}=40.23kg **M_{TOT}=1.95kgm**

ROLLING CONDITIONS (CS-VLA § 349b)

Cmo_1/4_22 – the moment coefficient increment for –22° aileron deflection
Cmo_1/4_14 – the moment coefficient increment for 14° aileron deflection
Load §349 - 2/3 of the load specified under CS VLA 455

	Speed	Load	Load § 349	Cmo_1/4_22 $\delta = -22$	Cmo_1/4_14 $\delta = 14$
VA	85	2.439,22	1658,9	0,131	-0,229
VC	94,8	2.320,56	1579,8	0,131	-0,229
VD	132,7	2.513,74	1708,6	-0,016	-0,136

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