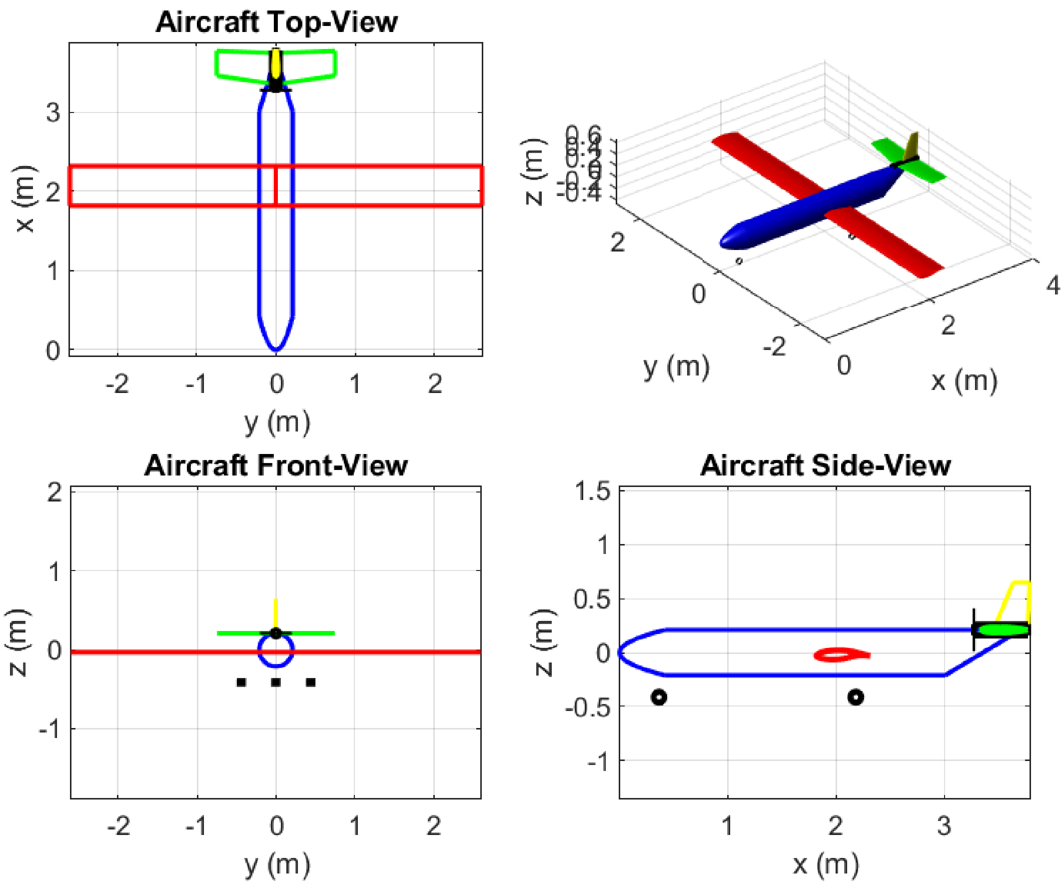
Flight Loads: DroneVLA aircraft



Pierluigi Della Vecchia

Design of Aircraft and Flight Technologies, DAF

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Chapter 1. Introduction

This document defines the SUBPART C - Structure - Flight Loads of the:DroneVLA.The boundaries of the flight envelope will be defined within this document. All speeds are calibrated airspeeds (CAS) (requirement 4.4 [1])and given in knots if not stated otherwise.All other units used are metric (SI units).The weights are given in mass units (kg) but the formulas require force units as input,therefore these are calculated in place wherever they are used.Note: The speeds defined within this document should be used for the placards,speed markings, aeroplane flight manual (limitations), load calculations and need to be verified by flight test.

Chapter 2. References

1. ASTM F2245-12d,” ASTM.“ASTM F2245-12d, ASTM.
2. ABCD-FL-57-00 Wing Load Calculation, EASA.
3. ISO 2533:1975, International Standardization Organization, 1975.
4. CS-LSA Certification Specifications and Acceptable Means of Compliance, Amnd.1 29.Jul.2013, EASA, 2013.
5. “ABCD-FTR-01-00 Flight Test Report,” EASA.
6. L. Smith, “NACA technical note 1945, ‘Aerodynamic characteristics of 15 NACA airfoil sections at seven Reynolds numbers from 0.7x10E6 to 9x10E6,” 1949.
7. ABCD-WB-08-00 Weight and Balance Report, EASA.

HERE BELOW AN EXAMPLE OF REFERENCES TO BE EDITED

Chapter 3. List of Abbreviations

- CL = lift coefficient
- CD....
- ...
- ...
- ...
- ...
- ...

ADD HERE list of abbreviations as a formatted table....to be created

Chapter 4. Aircraft data

Add here all the aircraft geometrical, aero and inertial and masses data useful for following paragraph

4.1. Geometry

The aircraft reference geometry is summarized in table:Ref:wingRef:horiRef:vertRef:fus

Table 4.1. Wing Geometrical Parameters

Wing parameters	Value	Measure unit
b	5.2	meters
S	2.589	square meters
AR	10.446	-
taper	1	Non dimensional
sweep	0	degrees
sweep_location	0	percentage
secondary_sweep_location	0	percentage
croot	0.498	m
ctip	0.498	m
xle	1.638	meters
yle	0	meters
zle	0.165	meters
xtip_le	NaN	% fuselage length
dihedral	0	degrees
mac	0.498	m
xmac	NaN	% fuselage length
ymac	NaN	% semispan
ypos	NaN	% semispan
zpos	NaN	% fuselage diameter
camberloc	0.15	Percentage
thickchord	0.18	Percentage
twist_angle	3	degrees

The aircraft reference geometry is summarized in table:Ref:wingRef:horiRef:vertRef:fus

Table 4.2. horizontal Geometrical Parameters

horizontal parameters	Value	Measure unit
S	0.529	square meters

horizontal parameters	Value	Measure unit
l	1.492	meters
camber	0	percentage
camberloc	NaN	percentage
thickchord	0.12	percentage
twist	0	degrees
twistloc	0.25	percentage
xloc0	1.49	meters
xloc	3.128	meters
yloc	0	meters
zloc	0.15	meters
xrot	0	meters
yrot	0	meters
zrot	0	meters
b	1.496	meters
ctip	0.3136	meters
croot	0.3929	meters
sweep	15	degrees
sweeploc	0	percentage
secsweeploc	1	percentage
dihedral	0	degrees
location_of_camber	0.2	percentage
secondary_sweep_location	1	percentage

The aircraft reference geometry is summarized in table:Ref:wingRef:horiRef:vertRef:fus

Table 4.3. Vertical Geometrical Parameters

vertical parameters	Value	Measure unit
xle	0.95	% of fuselage length
croot	0.3136	m
ctip	0.15347	m
xtip_le	1	% of fuselage length
b	0.4375	m
zpos	1	% of df
MAC	0.23354	m
l_vt	1.65	m

The aircraft reference geometry is summarized in table:Ref:wingRef:horiRef:vertRef:fus

Table 4.4. Fuselage Geometrical Parameters

Fuselage parameters	Value	Measure unit
length	3.64	meters
diameter	0.42	meters
Non_dim_radius_of_gyration	0.34	Non dimensional
Radius_of_gyration	NaN	meters

4.2. Aerodynamic

The aircraft reference aerodynamic is in figure:polars_wb

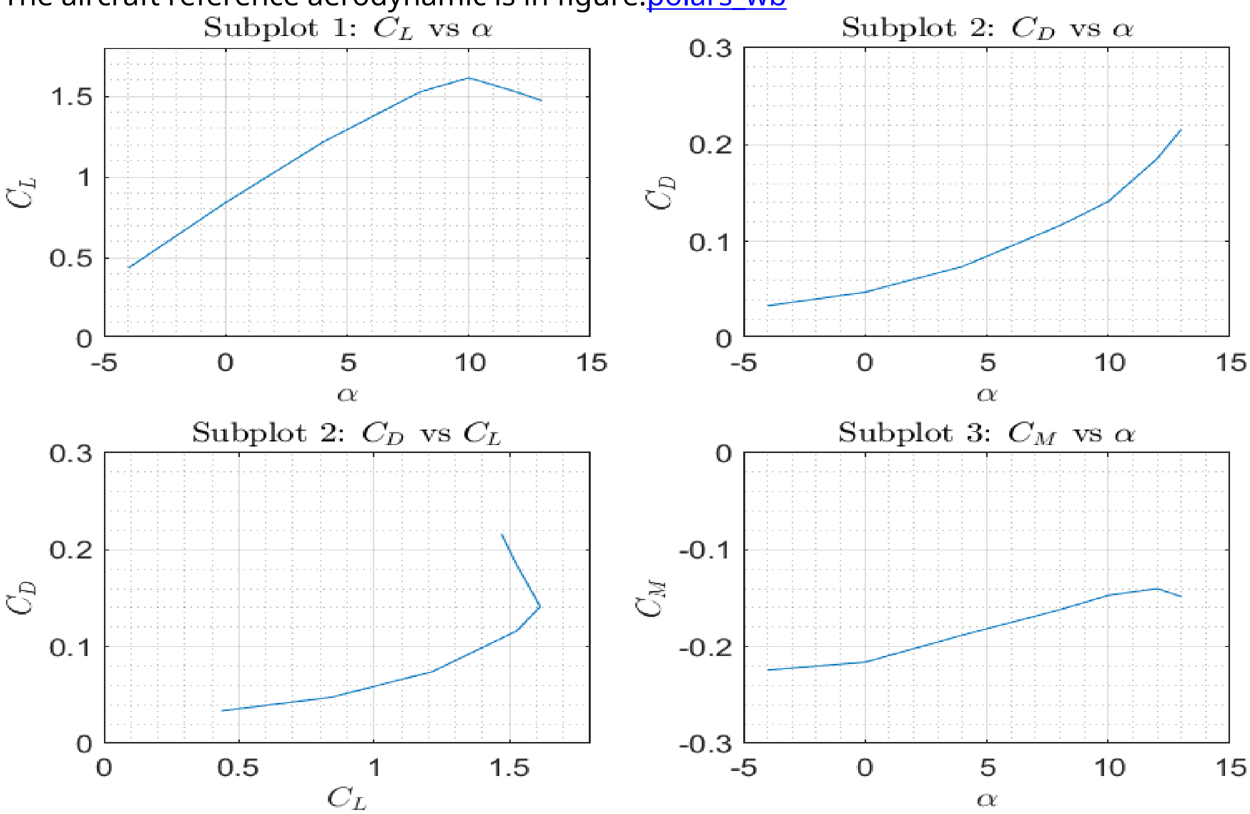

Figure 4.1. Wing-Body reference Aerodynamics

Chapter 5. Design Airspeeds

This chapter defines the operating and design airspeeds as required for certification REFFFF

5.1. Maximum speed in level flight VH

According to flight tests [5] at maximum weight and maximum continuouspower at sea level conditions, the maximum speed in level flight has been determined:V_H=130\ kts

5.2. Stall speeds VS, VS0, VS1

These speeds will be verified by flight test according to requirement 4.4.1 [1]In order to calculate the stall speed, the maximum lift coefficient of the aeroplane as a whole is determined first.The maximum lift coefficient of the aeroplane has been calculated starting from the polar curve of the wing profiletaken form ref. [6] (p. 236, Re=2.9E6 flaps retracted c_(L_profile_max)=1.35 and p.237, δ_f=40 deg for the flapsin landing configurationc_(L_profile_flapped_max)=2.15, and δ_f=10 deg in take-off configurationc_(L_profile_flapped_to)=1.70).Considering the horizontal tail balancing force and the lower total wing lift due to wing lift distribution,the total aeroplane lift coefficient has been lowered by 15% with respect to the one of the profile.

Flaps retracted(cleam configuration):

$$V_S = \sqrt{\frac{2\,W_{MTOM}}{\rho_0 C_{L_{MAX_{Clean}}} S}} = \sqrt{\frac{2*981}{1.225*1.58*2.589}} = 19.7839 m/s$$

Flaps extended(Landing configuration):

$$V_{S_0} = \sqrt{\frac{2\,W_{MTOM}}{\rho_0 C_{L_{MAX_{Landing}}} S}}$$

Flaps extended(Take-off configuration):

$$V_{S_1} = \sqrt{\frac{2\,W_{MTOM}}{\rho_0 C_{L_{MAX_{Takeoff}}} S}}$$

Therefore aeroplane lift coefficient is estimated toc_(L_clean_max)=0.85*1.35=1.15and for the landing configuration (since the span extension of the flaps is half of the span of the wing):c_(L_flaps_max)=(c_(L_profile_flapped_max)+ c_(L_profile_max))/ 2*0.85=(2.15+1.35)/2*0.85=1.49

The stall speed in landing configuration (flaps fully extended toxxx degrees degrees)isXXX kts.Therefore it is In accordance with CS-LSA.5 [4].In Take-Off configuration (flaps extended to ,xxx degreesdegrees) the stall speed is ,xxxkts.

(Note: These speeds are estimates. The methods for the estimation can be various.It is important that these estimations are as precise as possible. Flight tests will be used to validatethe stall speeds. In case the flight tests show different values, this might have an impact on the speedsused for design and ultimately might impair the compliance to the CS-LSA.5.)

5.3. Design manoeuvring speed VA

According to requirementADD here reference REGULATION paragraph

5.4. Flaps maximum operating speed VF

According to requirementADD HERE REF,such speed shall be not less than the greater ofexample 1.4VS1.8VS0

The speed has been selected as:ADD HERE value of VF,

5.5. Flaps maximum operating speed VFE

On this aeroplane the maximum flap extension speed is identical to the flap operating speed VF.V_{FE}=V_F=90\ ktsThis speed is the maximum speed for flaps in take-off and landing configuration.

5.6. Design cruising speed VC

According to requirementADD req. par V_C may not be less than:V_{Cmin}=4.77\sqrt{\frac{\ W_{MTOM}}{S}}=\ 4.77\ \sqrt{\frac{600\ast9.81}{15.1\ }}=94\ ktsand need not be greater than:V_{Cmax}={0.9\ V}_H=0.9\ast140\ =126\ ktsThe speed has been selected as: V_C=120\ kts

5.7. Design dive speed VD

According to requirementADD req parV_D=1.4\ V_{Cmin}=1.4\ \ast94\ =132\ ktsFor V_D a higher value than the one above has been chosen:V_D=160\ kts

5.8. Demonstrated dive speed VDF

ADD TEXTS:

5.9. Never exceed speed VNE

ADD TEXTS:

Chapter 6. Altitude

The maximum permissible operational altitude is ADD H13000ft.Despite the CS-LSA requirements do not require to accounts for the effects of altitude,such effects have been considered up to 10000 ft. In fact the gust load factor have beencalculated at such altitude. This is considered acceptable since it covers the operationalrange within which the aeroplane will fly most of the time.

(Note: the CS-LSA requirement does not require to account for the effects of altitude.Calculating the loads at sea level would be acceptable.In this case, the choice to consider such effect up to 10000 ft is a decision of a designer, which would be accepted by the team.)

Chapter 7. Manoeuvring and Gust load factors n

Summary of limit load factors according to certification specifications and gust requirements.

7.1. Gust envelope

Gust load factors need to be considered because they can exceedthe prescribed maximum load factors at different weights and altitudes. Since gust loads depend on air density and aircraft mass they will be calculated for all twelve cases (sea level and 10000ft=FL100, maximum, minimum flying weight and minimum flying weight with full wing fuel tanks) according to requirement 5.2.3.3 [1] with flaps retracted (requirement 5.2.6.1 [1])and fully extended (requirement 5.2.6.2 [1]) at V_F.

The calculation is based on appendix X3 [1]. To calculate the gust loads at altitudes other than at sea level the formula X3.1 [1] is altered to include the density at sea level ρ_0 as well:

$$n_{3/4}=1\pm\frac{\frac{1}{2}\ \rho_0\ V\ K_g\ a\ U_{de}}{\left(\frac{w}{s}\right)}$$

The corresponding weights are defined within [7]. Since the gust loads on the wing and tail have been chosen to be treated together, a is the slope of the lift-curve of the aeroplane ($\left(\frac{{dc}_L}{\alpha}\right)_{aeroplane}=4.77\frac{1}{rad}$). (Note: the applicant should provide the method for the calculation of the slope of the lift-curve of the aeroplane)

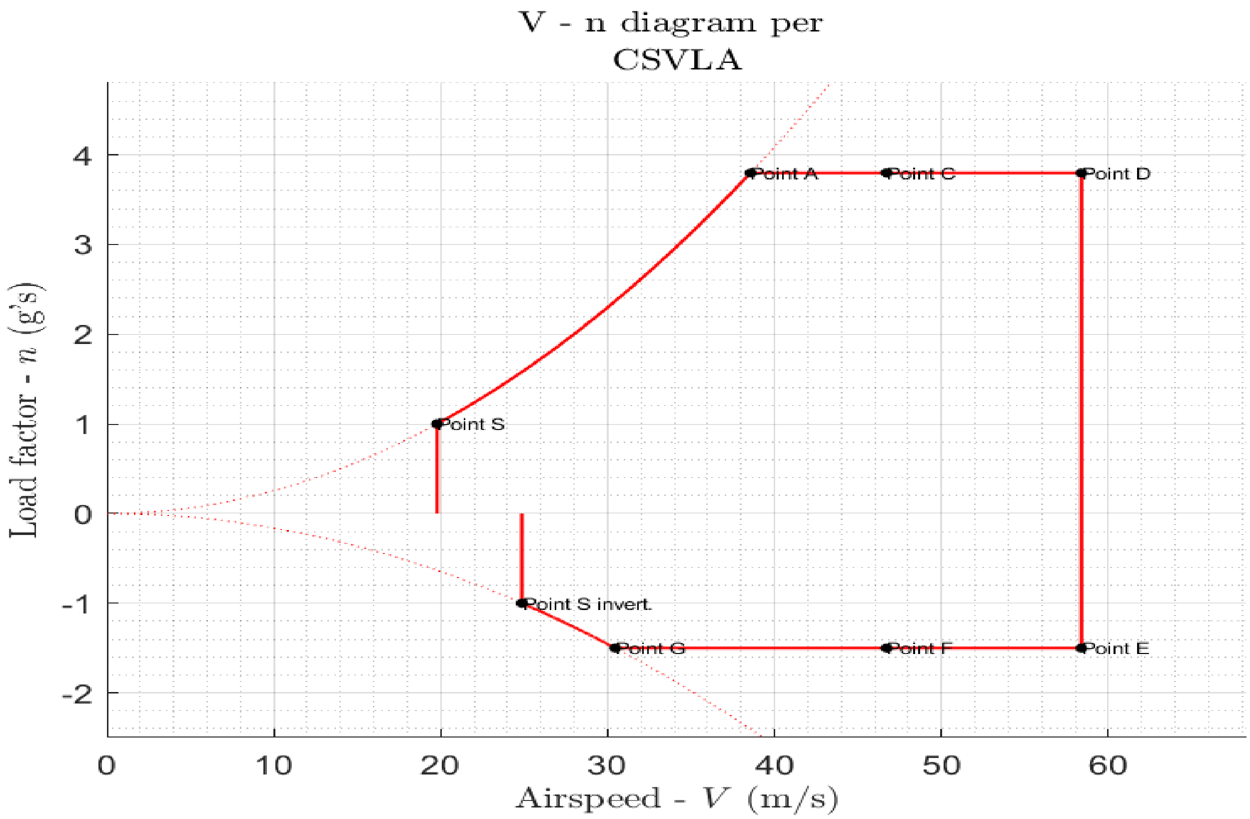

Figure 7.1. Maneuver and Gust load factors and diagram

Chapter 8. V-n Envelope

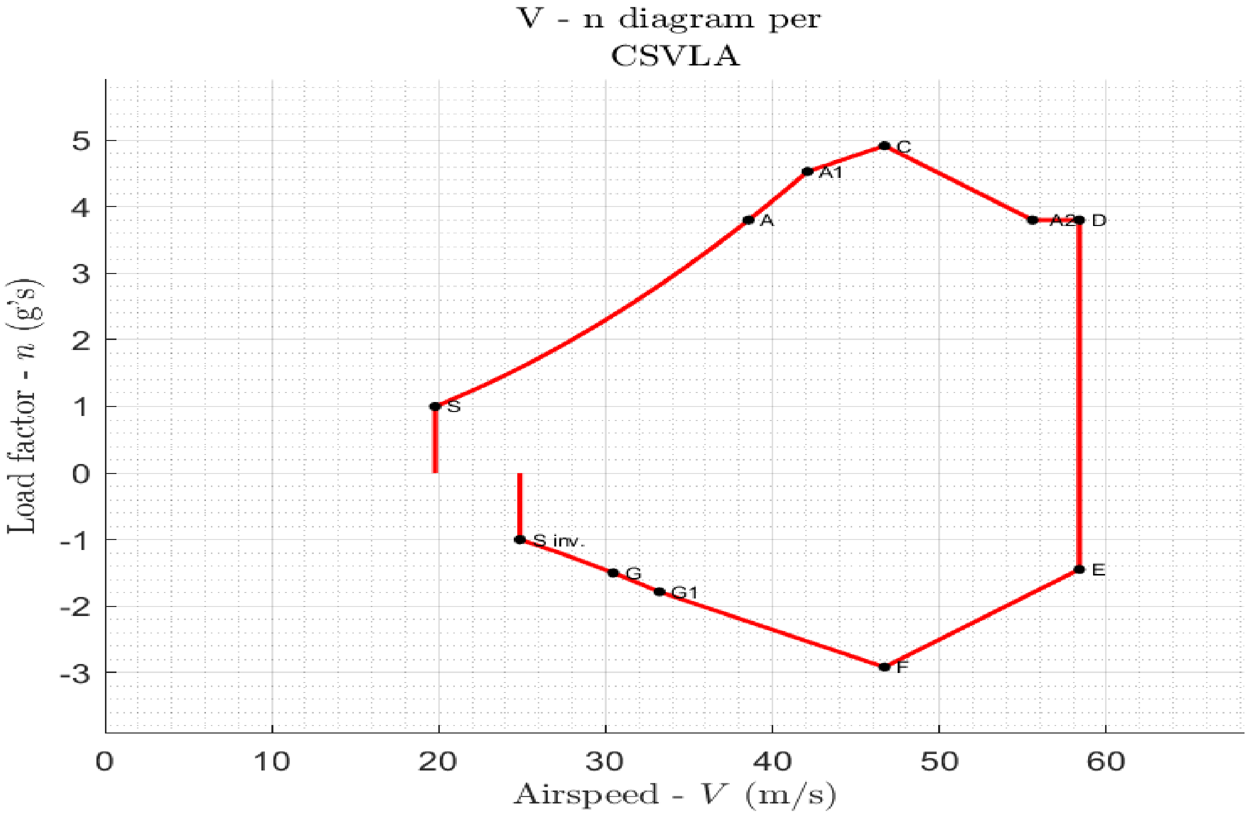

Figure 8.1. Maneuver and Gust load factors and diagram

ADD HERE V-n Envelope

Chapter 9. Loads on the aeroplane

ADD HERE details for balancing Equation

ADD HERE details for balancing Equation

9.1. Reference axes and sign convention

9.1.1. aaaaa

ADD HERE details for balancing Equation

9.2. Symmetrical flight conditions

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9.3. Aerodynamic centre

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9.4. Pitching moment of the wing

Chapter 10. Loads on the wing

ADD HERE details for balancing Equation

ADD HERE details for fuselage effect how are they accounted?

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ADD HERE details for balancing Equation

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10.2.2. Normal and parallel component

10.2.3. Shear, Bending and Torsion

10.2.4. Critical load condition

ADD HERE details for uns loads

10.3. Unsymmetrical loads

10.3.1. Rolling condition

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ADD HERE details

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ADD HERE details

11.2. Manouevring loads

11.2.1. Unchecked manoeuvre

11.2.2. Checked manoeuvre

11.2.3. Gust loads

ADD HERE details

11.3. Horizontal tail loads summary

ADD HERE details

11.4. Unsysmmetrical loads

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ADD HERE details

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12.1.2. a(2)

12.1.3. a(3)

12.1.4. Gust loads

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15.1. Engine torque

ADD HERE details

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15.3. Intertia load on engine mount

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